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THE
INTERNATIONAL ENCYCLOPÆDIA
OF
SURGERY.

VOL. V.

THE
INTERNATIONAL ENCYCLOPÆDIA
OF
SURGERY

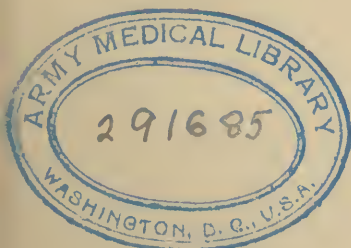
A SYSTEMATIC TREATISE
ON THE
THEORY AND PRACTICE OF SURGERY
BY
AUTHORS OF VARIOUS NATIONS

EDITED BY
JOHN ASHHURST, JR., M.D.
PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE
PENNSYLVANIA HOSPITAL, ETC.

ILLUSTRATED WITH CHROMO-LITHOGRAPHS AND WOOD-CUTS

IN SIX VOLUMES
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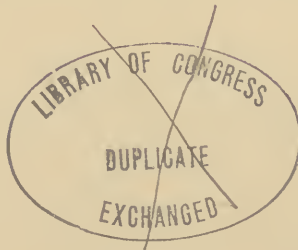


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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

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INJURIES OF THE HEAD. By CHARLES B. NANCREDE, M.D., Professor of General and Orthopædic Surgery in the Philadelphia Polyclinic; Surgeon to the Episcopal Hospital, and to St. Christopher's Hospital. Page 1.

MALFORMATIONS AND DISEASES OF THE HEAD. By FREDERICK TREVES, F.R.C.S., Assistant Surgeon to, and Lecturer on Anatomy at, the London Hospital. Page 111.

INJURIES AND DISEASES OF THE NECK. By SIR GEORGE H. B. MACLEOD, M.D., F.R.C.S. and F.R.S. Edin., Senior Surgeon to, and Lecturer on Clinical Surgery at, the Western Infirmary; Regius Professor of Surgery in the University of Glasgow; Surgeon in Ordinary to H. M. the Queen, in Scotland. Page 169.

INJURIES AND DISEASES OF THE AIR-PASSAGES. By J. SOLIS-COHEN, M.D., Professor of Diseases of the Throat and Chest in the Philadelphia Polyclinic, Honorary Professor of Laryngology in the Jefferson Medical College, Physician to the German Hospital, etc. Page 221.

INJURIES OF THE CHEST. By EDWARD H. BENNETT, M.D., F.R.C.S.I., President of the Royal College of Surgeons in Ireland; Professor of Surgery in Trinity College, Dublin; Surgeon to Sir Patrick Dun's Hospital, etc. Page 391.

DISEASES OF THE BREAST. By THOMAS ANNANDALE, F.R.C.S.E., Regius Professor of Clinical Surgery in the University of Edinburgh, and Senior Surgeon to the Edinburgh Royal Infirmary. Page 423.

INJURIES AND DISEASES OF THE ABDOMEN. By HENRY MORRIS, M.A. and M.B., Lond., F.R.C.S. Eng., Surgeon to, and Lecturer on Surgery at, the Middlesex Hospital, London. Page 451.

URINARY CALCULUS. By E. L. KEYES, A.M., M.D., Professor of Genito-urinary Surgery in the Bellevue Hospital Medical College of New York; Consulting Surgeon to the Charity Hospital; Surgeon to Bellevue Hospital, to the Skin and Cancer Hospital, and to St. Elizabeth Hospital. Page 713.

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ALPHABETICAL LIST OF AUTHORS.

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EDWARD H. BENNETT,
J. SOLIS-COHEN,
WILLIAM H. HINGSTON,
EDWARD L. KEYES,
GEORGE H. B. MACLEOD,
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By

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LITHOTRITY.

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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

INJURIES OF THE HEAD.

BY

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INJURIES OF THE SCALP.

CONTUSIONS and wounds of the scalp are among the most common injuries of civil life. A preliminary consideration of the anatomy of the scalp will explain certain pathological peculiarities of injuries of that structure.

The coverings of the skull, from without inward, are the skin, superficial fascia, aponeurosis and muscular bellies of the occipito-frontalis muscle, subaponeurotic cellular tissue, and pericranium. The integument is firmly bound to the subjacent muscle and aponeurosis by the so-called fascia, which consists of firm, interlacing bundles of fibrous tissue, in the interspaces of which are little pellet-like masses of granular fat, forming an exceedingly inelastic structure. In this ramify the numerous vessels and nerves of the scalp. A consideration of these anatomical points explains several well-known clinical facts, viz., that the inelastic, subcutaneous cellular tissue can actually be *indented* by a blow; that scalp wounds which do not penetrate the aponeurosis seldom gape to any extent; and that when a scalp-flap is formed, it necessarily carries its entire blood-supply with it, owing to the physical characters of the subaponeurotic cellular tissue which I shall presently consider. The origin and attachments of the aponeurosis and muscular bellies of the occipito-frontalis should be carefully borne in mind, as a knowledge of them renders easy the differential diagnosis between subaponeurotic collections of pus and erysipelas. The posterior bellies of the muscle arise from the outer two-thirds of the superior curved lines of the occipital bone, and from the mastoid process of the temporal. The space between them is occupied by the aponeurosis, which is attached to the occipital protuberance and to the inner thirds of the superior curved lines. The anterior muscular bellies are blended with the pyramidalis nasi, corrugator supercilii, and orbicularis palpebrarum on each

side. The aponeurosis covers the whole vault of the skull, and is continued laterally by a laminated layer of areolar tissue to the zygoma. Hence it will be seen that subaponeurotic fluid collections cannot pass lower, posteriorly, than the points of attachment of the trapezii muscles; that anteriorly, fluid will gravitate into the eyelids and form a pouch over the root of the nose; and that laterally, the zygomatic arch is the lowest point attainable for a purulent collection. The cellular tissue which forms the bond of connection between the aponeurosis and the pericranium is exceedingly lax, permitting the former with its firmly adherent integument to glide readily over the calvaria. It will be at once seen that a wound penetrating the aponeurosis, on account of this laxity of the cellular tissue, will gape, and if raised in the form of flap may be extensively displaced.

The vascular and nervous supplies of the scalp must not be forgotten with reference to the arrest of hemorrhage, and the neuralgias that occasionally follow injuries. The arteries of the scalp are derived from the temporal, occipital, auricular, supra-orbital, and frontal. Vessels arising from these trunks penetrate the deeper structures to ramify in the periosteum. The veins of the pericranium and of the scalp, the diploic veins, and those of the dura mater, or even the cerebral sinuses, intercommunicate, thus presenting in their cellular coats a continuous tract of connective tissue, along which external inflammation may travel to the diploë, and even to the brain. The nerves of the scalp are the occipitalis major and occipitalis minor, the auriculo-temporal, the posterior auricular, the supra-orbital, and the facial.

CONTUSIONS OF THE SCALP.—Owing to the anatomical structure of the scalp, certain peculiarities of form are presented by contusions, which sometimes give rise to difficulties in diagnosis. The swelling from a blow upon the scalp occurs within a few seconds, and is due to the rapid effusion of blood and serum. It is sharply defined, and does not insensibly blend with the surrounding parts. If examined within a few hours, a soft, central depression is felt, surrounded by a hard, elevated margin, giving the impression of a depressed fracture; and this is all the more deceptive if, as in some instances, a ruptured artery communicates with the effusion, when the sensation communicated to the hand closely simulates that of cerebral pulsation.¹ The central depression with the surrounding hard margin, receives its explanation from the character of the dense, inelastic, cellulo-adipose, superficial fascia, which is *indented* at the point of impact, while the displaced fat, with the surrounding parts infiltrated with blood and serum, forms the hard margin.

The *diagnosis* between this condition and a depressed fracture, can be made by pressing firmly with the finger at the bottom of the depression; if there be no fracture, the surface can be still further indented, when the bone will usually be detected smooth and undepressed. The indurated margin itself can also be indented by pressure with the finger nail, which would not be the case in fracture. There are, besides, no symptoms of cerebral compression. It must be confessed, however, that, in certain instances, experienced surgeons have cut down expecting to find a depressed fracture where none has existed, and again, that, after the effusion has been absorbed, a depression has been found where none had been supposed to exist. Attention to the diagnostic points just detailed should render such mistakes of rare occurrence. The degree of the contusing force may be so slight that the consequences pass away within a few hours, or so severe as to actually pulpify the scalp, although gangrene is of rare occurrence.

¹ J. L. Petit gives an account of two such cases. *Œuvres complètes*, p. 334. Paris, 1844.

Complications and Sequelæ.—Contusion of bone, cerebral concussion, rupture of a scalp-artery, intra-cranial hemorrhage, and erysipelas may complicate contusions of the scalp. Abscess, neuralgia, cephalhæmatoma, traumatic aneurism, and pyæmia—the latter usually the result of bone-contusion—are occasional sequelæ. Numerous other after-effects of scalp contusions have been described, but they are really the results of injuries of the scalp-nerves, of an undetected cranial fracture, or of secondary brain lesions.¹

Treatment.—Quiet, for cerebral complications may arise; cold, evaporating lotions, such as spirit and water, or muriate of ammonium in solution—or even a bladder of pounded ice, if the effusion tend to spread, or pulsate—and attention to the state of the bowels, amply suffice for the majority of cases. If suppuration occur, the treatment should be that of an abscess elsewhere. If a traumatic aneurism form, compression or acupressure of the vessel should be resorted to. Erysipelas, cerebral concussion, contusion of bone, and pyæmia, will be considered in connection with wounds of the scalp.² Neuralgias must be treated upon general principles, or by excision of the scar, if they prove obstinate.

EFFUSIONS OF BLOOD.—These may occur, 1, in the dense subcutaneous tissue, where the blood forms a hard, unyielding lump; 2, in the subaponeurotic cellular tissue, either (*a*) circumscribed, or (*b*) diffused, when it sometimes forms a swelling of considerable extent, giving a crackling sensation when pressed by the finger; and 3, beneath the pericranium. In the last two situations, these collections have been called *cephalhæmatomata*. The nature of the contents varies with the time after the accident at which they are examined. The blood may “be arterial or venous, in a more or less fluid state; or a thick, viscid fluid of a dark, bistre color; or bloody serum with clots; or serum alone.”³ The wall of the cavity, originally formed by condensation of the environing tissues, eventually becomes lined with a serous-like, secreting membrane. Sometimes the sac is lined with layers of “fibrine” (lymph?) presenting the appearances found in a consolidating aneurism, or in a solidified bursal tumor.⁴

Cephalhæmatomata.—Certain examples of the so-called *caput succedaneum* of the newly-born, the result of tedious or instrumental labor, are entirely or chiefly filled with blood, although from their rapid disappearance the majority certainly seem to be due merely to serous effusion. A *caput succedaneum* is usually described as being subaponeurotic, but Agnew considers this to be an error, and believes that the majority are simply subcutaneous. When these swellings, due to effused blood, are diffused at the outset, they must certainly be of the subaponeurotic form; but when circumscribed from the first, they may be either subcutaneous or subpericranial.

Subaponeurotic cephalhæmatomata occur in the form of soft, fluctuating tumors, usually situated over one parietal eminence.⁵ The margins of the swelling are somewhat indurated. Although considered almost peculiar to the newly-born, they are, according to Gant, of frequent occurrence in older children as the result of falls or blows.⁶ I have myself seen a very large one upon the head of a boy about thirteen years of age.

Subpericranial cephalhæmatomata are of very rare occurrence, according to

¹ Gross, System of Surgery, 6th ed., vol. ii. p. 21.

² See page 4.

³ Hewett, Holmes's System of Surgery, 3d ed., vol. i. p. 574.

⁴ See Hewett, *ibid.*; and Vol. III., page 140, of this Encyclopædia.

⁵ Bryant records a large one over the occipital bone. Manual for the Practice of Surgery, 2d Am. ed., p. 154.

⁶ Science and Practice of Surgery, vol. ii. p. 147.

Vogel, not being found oftener than once or twice in a thousand births. They are more common after first labors, and, according to Bouchard, more common in boys than in girls, in the proportion of 34 to 9.¹ Commonly situated over one or other parietal bone, they are not infrequently multiple. They are usually small, being seldom larger than a walnut. A distinguishing peculiarity is the fact that, owing to the firmer adhesions of the periosteum at the sutures than elsewhere, these tumors are always confined to *one* bone, never passing a suture. Universally believed to be confined to the newly-born, as indicated by the terms *Cephalhæmatoma neonatorum* and *Thrombus neonatorum*, Gant reports the case of a child five years old, in whom a blood-tumor formed as the result of a blow over the right frontal eminence, and presented all the characteristics of a subpericranial effusion.

The characteristic symptoms of the lesion are apt to be obscured by the oedematous swelling of the superjacent scalp, for the first few days after birth, but from the fourth to the sixth day, a soft, circumscribed, fluctuating swelling confined to one bone—usually the right parietal—can be readily detected, while the overlying scalp is not discolored. The centre is soft, while the circumference is hard, and has very much the feel of a margin of bone surrounding a depressed fracture. There are, however, no brain symptoms when firm pressure is made at the bottom of the depression, and by the same manœuvre the finger can often detect the sound, undepressed bone.

Valleix has shown, from his studies of the pathology of this affection, that the hard, crater-like margin is due to the formation of plastic and osseous matter between the pericranium and the bone, and that, upon the side of the cavity, it has abrupt, almost perpendicular, walls, while the outer margin of the ring insensibly slopes down to the level of the surrounding bone. The pericranium is elevated by the blood-effusion from the subjacent bone, both structures being covered with plastic matter, but otherwise healthy. Sir James Simpson has observed that at times the plastic effusion upon the under surface of the pericranium becomes ossified, when pressure upon the resultant thin plate of bone communicates a crackling sensation to the finger.

The *diagnosis* of cephalhematomata, both general and differential, has been sufficiently indicated in the foregoing descriptions, except as to the necessity which may arise of distinguishing between pus and blood. In the former case, the collection would appear at a later period than a blood-effusion, and only after precedent symptoms of inflammation.

Treatment.—This should in no wise differ from that advised for contusions of the scalp. If, as occasionally is the case, the swelling persists, or even increases, aspiration, or a valvular puncture, may become necessary, after which firm compression should be kept up over the site of the swelling for a considerable time. The sac will sometimes refill, again and again, requiring repeated tapplings. Should the fluid be or become serous after several tapplings, and tend to re-form, an injection of iodine may be tried. If pus form, either spontaneously or as the result of attempts to get rid of the effusion, free incisions, followed by the use of antiseptic injections and dressings, should not be delayed.

WOUNDS OF THE SCALP.—These may be incised, punctured, contused, or lacerated. *Incised wounds* differ in no respect from those of other regions. *Punctured wounds* are more apt to be followed by trouble, because the vulnerating body punctures the various planes of tissues forming the scalp at points which do not correspond, owing to the freedom of movement enjoyed by the occipito-frontal aponeurosis, and, in consequence, the resultant effusions

¹ Erichsen, *Science and Art of Surgery*, Am. ed., vol. i. p. 529.

cannot get vent, but become widely diffused, setting up the most violent inflammation in those of intemperate habits, or with constitutions broken down from any cause. Even those in apparently robust health do not always escape. *Contused and lacerated wounds* are usually the result of heavy blows, such as falls, blows from bludgeons, etc. Because a wound appears clean-cut, as if incised, it cannot always be inferred that the vulnerating body was sharp, as, owing to the firmness of the subjacent bone, a fall on a plane surface will oftentimes give rise to wounds which closely resemble those made by cutting instruments. I merely mention this fact on account of its medico-legal bearings. These wounds when extending through the aponeurosis, gape markedly, and most extensive flaps may be formed, the scalp falling down over the face, upon the back of the neck, etc. Even the ears are sometimes torn off with lateral flaps. Usually a large portion of these wounds unites by first intention, and where this fails, healing by granulation completes the cure. As these flaps carry their entire vascular supply with them, sloughing is very limited, and the most mangled, bruised-looking scalp-tissue may recover its vitality. It is a golden rule to let nature, not the surgeon's knife or scissors, determine what portion of an injured scalp shall be removed. Portions of the pericranium may also be torn off with the flap, or destroyed, by the body producing the injury. But even extensive denudation of the bone does not necessarily involve exfoliation of the external table of the skull, for in most instances the separated flap adheres. If primary union fails, either granulations cover in the bone from the surrounding tissues, or the outer table becomes vascularized from the diploë, so that sometimes merely small scales are thrown off, while at other times no osseous tissue can be detected in the discharges.¹

Prognosis.—Scalp wounds are chiefly dangerous from their complications, which will be presently considered. Even complete scalping, with removal of the pericranium, may be recovered from.²

Treatment.—If the wound be of any size, the scalp must be shaved in its vicinity. Careful search having been made for any foreign bodies, or for a possible fracture, the wound should be thoroughly cleansed with some antiseptic solution, the best being mercuric bichloride, one part to two thousand. I have not mentioned the arrest of hemorrhage, which is usually free, because if it have not ceased from exposure to the air and washing with the bichloride solution, the subsequent dressing with compresses and bandage will usually be all that is necessary. If this do not suffice, both ends of the divided vessels can usually be readily either twisted or tied. Sometimes the ends retract into the dense fibro-cellular tissue, where they can be best secured by passing a needle armed with a ligature around the vessel, including some of the surrounding tissues. Ligatures are rarely necessary except when the patients are drunk and unruly, when I have known them to pull off the dressings and start the hemorrhage afresh. A wound involving the lower part of the temporal fossa may, however, give rise to hemorrhage which may prove difficult to arrest. "Should the bleeding recur and become dangerous, notwithstanding all our local means, the question of applying a ligature to the external or to the common carotid artery may arise."³ Various measures have been recommended for coaptating scalp wounds. If of moderate size, and not gaping much, small locks of hair on opposite sides of the wound may be passed through perforated shot, which can then be clamped, as Agnew suggests. I have achieved the same result by tying together locks

¹ See page 8 for treatment of denuded external table by drilling into diploë.

² Agnew, *Principles and Practice of Surgery*, vol. i. p. 257.

³ Hewett, *Holmes's System of Surgery*, 3d ed., vol. i. p. 570.

of hair, and fixing them with collodion. Owing to the rapid growth of hair, it is difficult to make adhesive plaster hold for any length of time, while the flowing blood interferes with its proper application at the primary dressing. I prefer, therefore, where sutures are deemed inadvisable, to fix one end of a strip of fine gauze or mosquito-netting with collodion on one side of the cut, when the wound can be accurately coaptated, and held so by painting the other end of the gauze-strip with more collodion, the drying and consequent fixation of the dressing being hastened by blowing with the breath. In this way the most extensive wounds can be as accurately approximated as by means of sutures, and almost as rapidly. With such a dressing at our disposal, sutures are rarely demanded. I am not opposed to their use when deemed necessary—at points of great traction, or in drunken or unruly patients—but anything like an attempt to closely sew up a lacerated scalp wound is to be deprecated, owing to the great ease with which the sub-aponeurotic fascia permits the diffusion of inflammatory products. Although as a rule I believe sutures to be unnecessary, with the above restrictions I should advise their use, provided that the anatomical peculiarities of the parts be borne in mind, and the sutures cut on the first symptoms of inflammatory swelling. Whatever the means used in closing the wound, care should be exercised lest the edges become inverted, as the hairs in their growth will interfere with healing. Contact of the flap with the deeper parts being secured by proper compresses, which also tend to prevent any collection of inflammatory products, a few folds of lint wet with a bichloride-of-mercury solution, and covered with waxed paper or oiled silk, should be laid over the line of the wound, and the whole firmly bandaged in place.¹ Where any special dressing is not available, I have seen the best results from coaptating the wound by bandaging with dry compresses. Whatever the dressing, I would advise inspection of the wound at the end of forty-eight hours, when it can be either redressed, or left undisturbed, according to circumstances. Quiet, and attention to the state of the bowels, should be enjoined in view of possible cerebral complications.

When suppuration takes place, the pus, if situated in the superficial fascia, forms circumscribed collections, which heal kindly after evacuation; but when the abscess is subaponeurotic, it will be diffused, and must then be freely opened at the most dependent points to insure free drainage. Should this condition escape early recognition, the scalp may slough, or, more probably, the aponeurosis with its subjacent tissue, when the pericranium is almost certain to be more or less destroyed, imperilling the vitality of the outer table of the skull. Incisions, when made, should run parallel to the course of the occipito-frontal fibres.

COMPLICATIONS OF SCALP WOUNDS.—*Erysipelas*.—This affection has been already treated of in so exhaustive a manner, in Vol. I. of this work, as to render superfluous anything further than the indication of those peculiarities, due to the tissues in which it arises, which the disease presents, and the modifications in treatment which the concomitant injuries demand. It certainly is most apt to occur in drinkers, or in those with broken-down constitutions. The most common form is the cutaneous, which is rarely grave, and which may be ushered in by symptoms that are somewhat puzzling. Thus, I have lately had a case of trephining, in which violent headache, coated tongue, vomiting, steadily rising temperature, and the presence of a few enlarged and tender lymphatic glands, preceded, by more than forty-eight hours, a marked

¹ The bichloride gauze, when at hand, may be substituted; or carbolized gauze, or carbolized solution.

attack of erysipelas, which was chiefly facial, and which, when I saw it, did not seem to affect the neighborhood of the wound. This precedence of the general over the local symptoms, and the implication of the lymphatic glands, should be borne in mind in head injuries, when otherwise unaccountable, feverish symptoms arise.

In the *treatment* of this affection, attention to the bowels, nutritious food, stimulants, in those accustomed to their use and when not contra-indicated by the cerebral conditions, and iron and quinia, are all that need be resorted to. At times the patient experiences relief from the burning, tingling, cutaneous pain by the application of cloths wet with lead-water and laudanum, or with simple mucilage of sassafras pith.

Phlegmonous erysipelas, a much more serious affection, is apt to be ushered in by marked constitutional symptoms.¹ It shows itself at first by slight puffiness near the wound, without redness of the skin. From plastic effusion, the scalp soon becomes greatly thickened and indurated, and, if unrelieved, the disease may lead to extensive sloughing of the cellular tissue, the aponeurosis, the pericranium, or even the scalp itself. In consequence, the bone may be extensively denuded, and in certain cases more or less necrosis follows, although this is no more a necessary result than it is where wounds denude the bone.

Diagnosis.—From simple accumulation of pus or inflammatory products beneath the occipito-frontalis, erysipelas can be usually distinguished by remembering the points of attachment of the aponeurosis. Subaponeurotic pus may be accompanied by reddening of the skin somewhat beyond the attachments of the aponeurosis, but unless really complicated with erysipelas, the blush does not attack the ears, cheeks, etc. The pus can gravitate no lower than the zygoma, the upper eyelids, the attachments of the pyramidalis nasi, and the superior curved lines of the occipital bone behind, pouches being formed above the root of the nose, the zygoma, and the superior curved lines of the occipital. This condition, with the superficial blush which sometimes extends more over the face than I have described, has been often mistaken for erysipelas and attributed to the use of sutures, but it is in reality simply a dermatitis, due to retention of inflammatory products, which commonly declines when the imprisoned fluids have been drained away.²

As regards the *treatment* of phlegmonous erysipelas of the scalp, at the first onset of the local symptoms all stitches must be removed, the edges of the wound separated at a sufficient number of points to insure a free exit for the effused fluids, and poultices or water-dressings, covered with oiled silk or waxed paper, applied. The bowels should, if necessary, be opened by an enema or a mild saline purge, and the treatment just advised for the cutaneous variety of erysipelas, at once instituted. Despite these measures, should the plastic effusion extend, multiple punctures of the scalp, or, at most, numerous small incisions, will prove of advantage, and are not so likely to lead to free bleeding as the long incisions sometimes advised. Anything like free oozing, even from the punctures, must be checked as soon as possible, since these patients cannot afford to lose blood. In persons of previous good health, the relief of tension effected by these incisions usually suffices to prevent extensive sloughing, yet at times great destruction of cellular tissue, aponeurosis, and pericranium takes place, although from the peculiarities of the blood-supply of the scalp, already adverted to, this structure is rarely destroyed, at least to any considerable extent. A rare accident is the laying open of a large

¹ Local symptoms may precede the constitutional.

² Tetanus is an occasional complication. The reader is referred, for details, and a thorough consideration of all the varieties of erysipelas, to the article on that subject in Vol. I.

arterial trunk by ulceration, giving rise to hemorrhage, the source of which is often difficult to ascertain, owing to the accumulation of blood beneath the scalp. Pressure upon the main trunks of the scalp arteries should be tried in turn, until the right vessel is detected, when it may be compressed, acupressed, or tied.¹ A generous diet, iron and other tonics, carbonate of ammonium, and large quantities of stimulants, are, from the outset, often necessary to tide bad cases over the worst; but treated in the way described, it is astonishing how well they eventually do, the extensively separated scalp becoming adherent to the deeper structures, and the denuded bone being covered in by granulations. When the efforts of nature seem unequal to the task of vascularizing the denuded external table of the skull, left bare by the sloughing of the pericranium, the surgeon may drill with an awl a number of small holes close together into the diploë, and through these, as I have seen in a case of Agnew's, granulations may sprout.² The use of disinfectant injections beneath the separated scalp, counter-openings for the escape of pus and sloughs, and the application of compresses to prevent bagging of matter, are too manifest therapeutic indications to need more than this mention.

INJURIES OF THE SKULL.

CONTUSIONS OF BONE.—Those complications which render injuries of the scalp most formidable, originate, for the most part, in contusions of the skull. Caused, as they not unfrequently are, by slight blows, falls, injuries from spent balls “removing perhaps only the hair,”³ etc., the resultant symptoms, delayed and insidious, often escape detection until hopeless complications have supervened. Bone-contusion may result in one or all of these conditions: 1, rupture of the bloodvessels may occur between the pericranium and the bone, resulting in an effusion of blood, and secondarily of inflammatory effusions, which strip the membrane from the skull to a varying extent; 2, the same accidents may happen to the vessels running between the dura mater and the inner surface of the skull; and 3, the sinus-like veins of the diploë may be either bruised or ruptured, or the cancellous tissue itself may be broken down, the more elastic compact tables of the cranium escaping manifest injury. In the first two instances, the contiguous bone, deprived of one of its chief sources of blood, is apt to become necrosed with consequent suppuration. In the third case, an osteo-myelitis results which probably goes on to necrosis, suppuration, implication of the dura, and even of the brain and its membranes. In most instances, more than one of the conditions co-exist, usually the first and third. The osteo-myelitis⁴ set up by contusion may be observed under three conditions:—

1. It may occur as an acute disease, limited to the site of injury;
2. It may also be seen as a chronic affection, lasting for years, and resulting in either limited or general, irregular thickening of the inner or outer tables of the skull, or of both, causing perhaps, when the inner table is affected, epilepsy or maniacal seizures, provoked, most probably, by some temporary

¹ Agnew (op. cit., vol. i. p. 257) ascribes this advice to Hewett.

² This operation originated with a French frontier surgeon, and was said to have been so extensively practised in cases of scalping, and with such uniformly good results, that soon after its introduction every frontier post had persons who performed it. (Eve, *Remarkable Cases in Surgery*, p. 35. Philadelphia, 1857.)

³ Gant, op. cit., vol. ii. p. 148.

⁴ I prefer the term osteo-myelitis rather than osteitis, as the diploë sooner or later becomes affected.

increase of the chronic irritation; or necrosis of the outer or inner table may result, and even the whole calvaria may ultimately separate.¹

3. Osteo-myelitis, caused by a severe blow upon the skull, may also result in an atrophic condition.²

Symptoms of the Acute Form.—After a head injury involving a contusion of bone, the patient may at first complain of nothing, or at most of a persistent, dull headache. The next symptoms noted are, that not earlier than the sixth day, and usually not later than three weeks³ after the receipt of the injury, the patient begins to complain of malaise, headache, slight vertigo, abnormal acuity of the special senses, muscular feebleness or rigidity of the cervical muscles, fever, slight chilliness, and nausea or vomiting. The pupils are usually contracted. If there is a wound, the edges become everted, the previously healthy discharge becomes thin, ichorous, and gleety, the granulations lose their florid aspect, and become pale, and the periosteum secedes from the bone, leaving it dry, white, and discolored. If there is no wound, the site of injury becomes tender, and the scalp infiltrated with serum, producing a circumscribed, flattened, elevated swelling, the so-called “puffy tumor” of Pott, which indicates a subjacent suppurative periostitis, denuded bone, and in many instances subcranial suppuration with separation of the dura mater. The exceptions to this rule are not infrequent, and will receive future consideration. With these local conditions the constitutional keep pace, as indicated by increasing fever. Headache, delirium, drowsiness, and stupor steadily increase; one pupil is perhaps dilated while the other is contracted; and paralysis and convulsions may supervene, coma and death closing the scene.

In addition to the above, irregular chills, followed by high temperature; profuse sweatings; a rapid, feeble pulse; pain in the chest, with dyspnoea and cough; slight jaundice; and swollen, painful joints, may, one or all, be superadded to the local and general symptoms first described. If the disease do not pass beyond a certain point, recovery may ensue, although the patient is liable to suffer, according to Gault, from chronic cerebral irritation, epilepsy, imbecility, impaired vision or hearing, aphasia, and various palsies.

Let us inquire to what pathological changes these symptoms correspond. At first, there is a simple osteo-myelitis, with separation of the pericranium and slight constitutional reaction. The inflammation next spreads to the dura mater, which may have been separated by an effusion of blood caused by the original injury. Lymph and pus soon form. The inflammation, if unchecked, next attacks the arachnoid, when at once the process, up to this point circumscribed, extends over the free surface of that membrane. The visceral layer of the arachnoid soon becomes involved, and then the pia mater, and even the corresponding portion of the brain itself, become inflamed. Here we have a local inflammatory process, first producing bone suppuration and necrosis, then meningitis, and finally localized brain compression by intrameningeal or cerebral suppuration and abscess. When the second class

¹ “Dr. Abercrombie mentions a case in which the inner table alone of the calvaria was thus extensively destroyed.” (Holmes’s System of Surgery, vol. i. p. 571.) In Norris’s case, the disease attacked both tables of the whole of the calvaria, and extended even as far as the foramen magnum. (Transactions of the Medical Society of London, vol. i. p. 168.) But of all cases of this kind, Saviard’s is the most extraordinary. In this case, two years after a blow upon the head, the whole skullcap came bodily away. (Nouveau Recueil d’observations chirurgicales, p. 386. Paris, 1702. See also Œuvres de Sabatier, tome ii. p. 400. 1796; Agnew’s Surgery, vol. i. p. 260.) The assumption that constitutional syphilis has anything to do with these extensive exfoliations of bone, Agnew considers entirely gratuitous.

² Agnew, *ibid*.

³ On the average, about the thirteenth day. Dease thought that between the eighth and sixteenth days was the period most to be dreaded. (Observations on Wounds of the Head, etc. Dublin, 1760.)

of symptoms are superadded, such as rigors, dyspnœa, etc., or when they have existed coincidently with those first given, the veins of the scalp or diploë near the injury will be found filled with pus. Hewett also says that "the veins on the surface of the hemispheres are sometimes loaded with pus, and so too, and much more commonly, is the superior longitudinal sinus." In other words, we have the symptoms of pyæmia superadded to those of local osteo-myelitis of the cranium, intracranial suppuration, meningitis, and cerebral abscess. Pyæmia may arise from a simple scalp wound, but bone contusion from a slight head injury is the most common cause. I have described the symptoms of intracranial suppuration, meningitis, etc., with those of pyæmia, since although the brain and its membranes may remain perfectly healthy, the association of the two morbid conditions is much more common. The diagnosis between them, especially in their earlier stages, when no signs of pyæmia exist in other parts of the body, is exceedingly difficult.

Diagnosis.—In intracranial suppuration the earliest symptoms are apt to be those of meningeal and cerebral irritation, such as slight vertigo, headache, abnormal sensibility to light and sound, rigidity of the cervical muscles, broken and restless sleep, and a hard pulse of increased frequency. Subsequently, when symptoms of cerebral compression and paralysis occur, the diagnosis is usually clear enough. Upon the other hand, when pyæmia arises from suppurative osteomyelitis, it is so commonly preceded or attended by intracranial suppuration, that I think that many cases have been correctly regarded at first as non-pyæmic, which afterwards have become septic, so that we are left in doubt to which disease any one symptom or set of symptoms belongs, and are thus deprived of reliable data for a differential diagnosis. Pyæmia, although attended by malaise, slight headache, fever, etc., is not usually preceded by signs of cerebral irritation, but is succeeded by them. I must candidly confess that the distinctions which I have emphasized can be rarely drawn in practice as sharply as I have indicated them, but I am convinced that when a differential diagnosis is possible in the early stages of these affections, it can only be made by following out the line of thought and investigation just suggested. As to the value of the "puffy tumor" of Pott, I would say that it is simply indicative of a suppurative periostitis, or osteomyelitis, and that upon its appearance alone, or the spontaneous secession of the periosteum in an open wound, we cannot predicate separation of the dura mater and subcranial suppuration; but if such appearances coincide with paralytic, irritative, or convulsive symptoms on the opposite side of the body, supposing that the injury is in the anterior parietal region, the probabilities amount nearly to certainty that trephining will reveal subcranial or subdural suppuration, either immediately beneath, or near the diseased bone. Upon the other hand, should, in a case of bone contusion, the local signs of what the older authors thought subcranial suppuration, occur over the occiput, with hemiplegia or other paralysis, or convulsive movements on the side of injury, trephining would do no good, and the bone changes would really only be indicative of local periostitis, with injury or disease of some distant part of the encephalon.¹ A reference to the section on cerebral localization will indicate the facts upon which I found these conclusions.²

Treatment.—This should be mainly preventive. In any head injury involving a chance of bone contusion, the case should be closely watched, for, as has been well said, no injury of the head is so slight as to be despised, nor so

¹ Liston, Lectures on the Operations of Surgery, etc., edited by Mütter, p. 76. Philadelphia, 1846.

² See also sections on traumatic meningitis, cerebritis, etc.

great as to be despaired of. The simplest diet and quietude should be enforced, a watch being kept for those slight signs of meningeal irritation which have been mentioned.

The bowels should be kept freely opened. Should persistent headache with slight fever be detected, I should advise in the robust—and I would not draw the line too strictly—a rigid anti-phlogistic regimen and wet-cupping, or even venesection from a large orifice, the patient sitting upright. In cases where these measures seem contra-indicated, a full dose of calomel, followed by purgatives, low diet, and arterial sedatives, should be resorted to. Calomel in small doses should be exhibited sufficiently often to touch the gums in either class of cases. Cold to the head, and large doses of the bromides, are indicated, if the cephalalgia be marked. The plan of treatment suggested is opposed by some surgeons, upon the plea that many cases really prove to be pyæmic, and that in that event it would be prejudicial. I would ask how many cases of pyæmia from head injury recover under any plan of treatment? Doubtless some cases where the advice here given is followed, will be treated with unnecessary activity, but I maintain that no permanent harm will result, while some lives may be saved. I am not one of those who think that the loss of a few ounces of blood is a serious matter, having demonstrated, experimentally and clinically, its power of cutting short traumatic inflammation in its early stages. Once again, I only recommend these measures in the incipient stages of meningitis following bone contusion. Hewett considers that the cases which do well under this treatment, are really instances of meningitis “beginning not in the dura mater, but in the visceral layers of the brain, and dependent upon . . . concussion.” He may be right, but I think that the mere recovery of such cases is no valid argument against the correctness of the diagnosis. As the earliest symptoms indicative of commencing suppuration between the dura mater and bone, are those of incipient meningeal irritation, they should be so treated, especially as death results in such instances by extension of the inflammation to the meninges and the brain itself. I cannot help believing that in some instances the formation of pus between the dura mater and the bone is prevented. Suppose that the case is not seen until intracranial suppuration has taken place, what shall the surgeon do? If, as mentioned under the head of diagnosis, there is a reasonable probability of the presence of a subcranial or subdural abscess, he should trephine at once, and with a large instrument. Pott’s success was due to early, bold operation, and is explicable by the fact that in his cases the diseased process was circumscribed, that is, was incipient.¹

There is no reason why similarly favorable cases should not be met with nowadays, with equally prompt operative interference. Knowing as we now do that Pott’s local symptoms are merely the signs of a periostitis or osteomyelitis, and that cerebral localization can at least inform us that no localized subcranial suppuration at the site of injury can possibly account for the symptoms in certain instances, the trephine will be withheld in many cases that were uselessly operated upon in the past, and in some rare instances I believe that in the future the instrument will be used to evacuate pus from beneath an externally healthy bone, far distant from the injury and from the local signs of bone contusion. What if no pus between the dura mater and the bone be found? If the membrane pulsate normally, nothing beyond abandonment of the operation remains, unless the symptoms are such as would warrant puncture of the brain-substance. If the dura mater bulge up into the trephine-hole—perhaps even to the level of the external bone—and be without pulsation, it should be cautiously incised to give vent to subjacent pus. Some-

¹ Pott, *Injuries of the Head*, pp. 63–107. 1768.

times this procedure, by the removal of pressure over the abscess, permits the pus of a true cerebral abscess to make its way to the surface.

Schmucker¹ narrates the case of a grenadier who fell and struck his head against the corner of a stone, whereby a compound depressed fracture of the frontal bone was produced. On the following day trephining, with removal of the splinters and elevation of the bone, restored consciousness. The patient was in the best of spirits until the fifth day, when feverish symptoms set in, followed in twenty-four hours by bulging of the dry and brown dura mater into the trephine-hole. Puncture evacuated upwards of a tablespoonful of laudable pus from a superficial abscess of the brain. The symptoms disappeared, particles of the brain-tissue were cast off, and the patient was well in two months.² (Gross.)

A child of nine years, suffering from a compound depressed fracture of the frontal bone, was trephined by Petit.³ Fever with headache set in on the night of the fifth day, and on the following day the discolored and distended dura mater bulged into the opening. On being laid open, a tablespoonful of brown, fetid fluid escaped, but the symptoms increased until the night of the eleventh day, when the rapid improvement disclosed that a large abscess had burst, and had saturated the dressings with offensive matter. In two months the cure was complete. (Gross.)

In certain rare instances, where the surgeon has had good reason to believe in the existence of cerebral abscess, incisions into the brain-substance itself have been successfully made.⁴ The previous use of the exploring needle—or, better yet, the aspirating needle—would be proper in such cases. I shall now give the details of some cases of intracranial abscess treated by incision of the dura mater, which will indicate what seems to me the proper plan to be pursued under similar circumstances:—

An officer was struck on the occipital protuberance by a musket-ball. Symptoms of irritation of the brain having set in, Giersch applied the trephine, under the supposition that there was a fracture of the internal table, but the bone was found to be sound, and there was slight purulent effusion beneath it. On removing the dressings a few hours subsequently, the prominent dura mater was punctured, and a considerable amount of bloody matter evacuated. Rapid and complete recovery ensued.⁵ (Gross.)

A man struck his head against the corner of a writing-desk, and suffered from severe headache for several months. Mursinna removed three circles of the occipital bone and opened the dura mater, with the effect of giving vent to a very offensive yellowish fluid, which he regarded as a collection of disorganized blood.⁶ (Gross.)

De La Peyronie trephined the parietal bone of a lad for symptoms which made their appearance on the twenty-fifth day after a blow from a stone. On incising the inflamed dura mater, three and a half ounces of pus, which extended by the side of the falx down to the corpus callosum, escaped.⁷ Death occurred in a few days. (Gross.)

Mr. Dumville, of Manchester, removed a circle of the denuded frontal bone, for supposed abscess of the dura mater, three weeks after a scalp-wound. The membrane was inflamed and perforated at one point, from which, after the insertion and withdrawal of a probe, stinking matter spurted out.⁸ The patient recovered. (Gross.)

A man, aged 37 years, was struck over the supraorbital ridge, and marked symptoms of compression set in at the end of three weeks. Prof. Hughes applied the trephine at the injured spot, and found fragments of the inner table of the frontal bone depressed on the dura mater, without involvement of the outer table. Upon incising the dura mater and evacuating a quantity of pus, there was an immediate return to consciousness.⁹ (Gross.)

¹ Vermischte chirurgische Schriften, Bd. i. S. 283.

² This, as well as the following cases, is quoted from a paper on Compression of the Brain, by Prof. S. W. Gross. (Am. Jour. Med. Sciences, new series, vol. lxvi. p. 40-74.)

³ Traité des maladies chirurgicales, t. i. p. 91. 1790. ⁴ See page 82, *infra*.

⁵ Rust's Magazin für die gesammte Heilkunde, Bd. ii. S. 127.

⁶ Bruns, Handbuch der practischen Chirurgie, Abth. i. S. 937.

⁷ Hist. de l'Académ. Roy. des Sciences, p. 212. 1744.

⁸ British Med. Journ., vol. ii. p. 743. 1858.

⁹ Iowa Med. Journ., 1868, p. 34.

What, then, are the indications for or against the use of the trephine, when the diagnosis of intracranial suppuration from bone contusion has been arrived at? In the present state of our knowledge, I think that all we are warranted in saying is that the operation is both justifiable and, when performed early, likely to prove a valuable resource in several conditions:—

1. If, with a wound over the parietal bone, particularly when involving its anterior half, there are the local symptoms,¹ with hemiplegia, hemispasm, etc., of the opposite side, especially if only the upper or lower extremity is involved, trephining is clearly indicated.

2. If, with wounds over other portions of the skull, symptoms of intracranial suppuration supervene, with neither distinct paralysis nor muscular spasms restricted to one-half of the body, but with general convulsions, or convulsions upon one side and paralysis upon the other, the local symptoms being well marked, trephining may be tried, and in some instances, when done early and freely, may save life.²

3. When there are symptoms clearly referable to the neighborhood of the fissure of Rolando, whether there be local signs of bone trouble or not, I think that, in otherwise desperate cases, we may properly trephine at the points which will be indicated when treating of cerebral localization, with a fair prospect of finding pus, either between the dura mater and bone, or subdural, or cerebral. The prospects of success are in direct proportion to the limitation of the motor disturbances.

I consider that the operation, at the point of injury, is positively contra-indicated in the two following conditions:—

1. When the so-called local symptoms of intracranial suppuration, or the wound, is situated either over the frontal or the occipital region, with hemiplegia, hemispasm, or partial paralysis or spasm of the limbs, upon either the side of injury or the opposite half of the body.

2. When, with a wound over the parietal region, either with or without the local symptoms, the motor disturbances are on the side of the injury. In either of these cases it is useless to trephine at the site of the wound.

If pus wells up from the diploë while trephining, the prognosis is bad, as the case will probably prove pyæmic.

If trephining were a dangerous operation *per se*, I should be more chary in recommending it; but I hope to show hereafter that in itself, when skillfully performed, it adds little to the danger of the case. When dealing with cases which are almost inevitably fatal if unrelieved, I feel that even temerity is justifiable; much more a comparatively safe operation, which, even if it do no good, can result in no great harm.

In a general way, the following points may prove useful in forming an opinion:—

As a rule, the symptoms produced by the formation of pus between the dura mater and skull do not begin to appear before the sixth day, nor later than the beginning of the third week; those of suppurative meningitis usually appear about the eighth day, and are rarely delayed beyond the twenty-first; while those of cerebral abscess, except in rare instances, are not noted before the end of two weeks, and most commonly set in about the twenty-fifth day.

If purulent infection supervene upon bone contusion, nothing more can be done surgically than to evacuate pus wherever it is accessible, whether in the joints, the cellular tissue, the serous sacs, or the skull. Medically, a vigorous,

¹ "Puffy tumor;" or secession of the periosteum, if there is a wound.

² *Chirurgical Works of Percival Pott, F.R.S., ed. by Sir Jas. Earle, F.R.S., vol. i. p. 82. Phila., 1819.*

supporting treatment, with opiates to secure rest, should be resorted to. Mineral acids with bitter tonics are useful to check the diarrhoea sometimes present in blood-poisoning. Although pyæmic cases are usually fatal, occasionally one ends favorably, so that no efforts should be spared to prolong life.¹ Hewett thinks that kidney disease may be at the bottom of the pyæmia, as well as of the erysipelas, of head injuries. With renal complications, he thinks that the serous sacs are more apt to be attacked.

2. *Symptoms of the Chronic Form of Osteomyelitis.*—Beyond the bony enlargement, nothing but local tenderness with slight hyperplasia of the scalp can be detected, although from thickening of the inner table of the skull, epilepsy, mania, etc., may result.

Treatment.—The administration of iodide of potassium, either alone or combined with mercury, incisions, leeching, the local application of iodine, and repeated blisterings, may be tried. When a localized exostosis forms, after the delay of a few months to see whether its growth will not cease—as so frequently happens—it may be removed with the saw or bone-forceps. If necrosis result, the case should be here, as elsewhere, left to nature until the bone separates, when the sequestrum may be removed by appropriate incisions. The question of trephining for epilepsy will receive future consideration.

FRACTURES OF THE SKULL.—Fractures of the skull are naturally divided by anatomical peculiarities and pathological results into two classes, viz., those of the vault, and those of the base. A fracture of the vault, however, very often coexists with one of the base, and in fact some writers take the extreme view that this is always the case. That this is an error, I hope to demonstrate. Fractures of either class may be fissured, incised, punctured, comminuted, or depressed.² Those of the vault may involve the external table alone, with crushing of the diploë; or the internal table may be comminuted and depressed, without any apparent injury of the external table; or the fragments may be elevated above the level of the sound bone. Finally, fractures of either class may be simple, that is, without any wound of the soft parts communicating with the fracture, or they may be compound, that is, with a lesion of the soft parts leading down to the injured bone.

One important difference between compound and simple fractures must be here adverted to. In the former, the force being almost of necessity applied to a small portion of the skull, the fracture is more frequently strictly limited to the point struck than in simple fractures, where the force is so diffused as not to be sufficient at any one point to divide the integuments. Thus in eight cases of compound fracture out of twenty examined, the fracture corresponded to the point struck, while this was found to be the case in only one instance out of fifty-six examples of simple fracture.

The anatomy of the scalp has already been sufficiently dilated upon to explain certain appearances presented by head injuries. A little reflection will indicate what an important part it plays in protecting the skull from fracture, its mobility converting many a direct into a glancing blow, thus avoiding fracture, or modifying its extent. The frangibility of skulls varies exceedingly. Other things being equal, the thinner the skull the more brittle, usually from the almost complete absence of diploë. Some skulls are translucent throughout nearly their entire extent, and are mere shells of compact tissue. Other skulls may average half an inch in thickness. Comparatively thick crania, however, may be quite brittle, but a thin one is always so for the reason just given, that is, the deficiency of diploë.

¹ I have found digitalis invaluable in cases of exhausting surgical disease, with frequent feeble pulse and high temperature. It is specially useful when the secretion of the kidneys is deficient, or likely to become so.

² Holmes's System of Surgery, vol. i. p. 582.

At the outset, I wish to emphasize the fact that a fracture of the skull has no inherent danger, over and above similar injuries of other bones; indeed, not nearly as much if we except the peculiar arrangement of its diploë venous channels, which predisposes to purulent infection. I repeat again, a fracture of the skull *per se* is not a dangerous injury, and I thus reiterate the statement in order to point out the error, too often made, of concentrating attention upon the fracture instead of upon the concomitant cerebral injuries, and because so much has been written concerning the risk of converting a simple into a compound fracture by incising the integuments, when the former presents symptoms of cerebral compression, forgetting that, though making a fracture of the thigh compound, directly imperils the patient's life, the course of the injury, as far as life is concerned, differs little in compound and simple fractures of the skull, provided that intracranial inflammation can be avoided.¹ I do not deny that intracranial complications may be aggravated by a reckless admission of air to a previously simple cranial fracture, but I deny that with modern antiseptic precautions the danger of the operation is to be compared to the risks of intracranial inflammation from the irritation of depressed fragments of bone, and that any comparison can be justly drawn between a compound fracture of a long bone and one of the skull.

I. FRACTURES OF THE VAULT OF THE SKULL.—These are usually the result of the direct application of force to a limited area of the skull, the bone yielding at the point struck. The resultant injury may be (1) a simple fissure, which is usually not limited to the site of injury, but may extend through several bones and even reach the basis crani, and (2) a comminution of the bones, which varies in extent, but which, resulting, as it most often does, from violent, concentrated force, is usually pretty much limited to the point of impact.

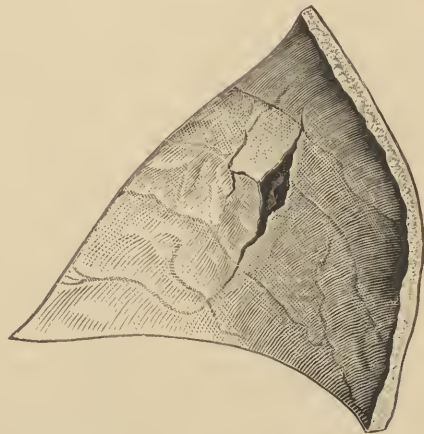
Although comminution commonly results from the application of concen-

Fig. 1075.



Indentation and fissuring of outer table of skull.

Fig. 1076.



Fracture of inner table of skull. From the same specimen as fig. 816.

trated force, occasionally diffuse force will produce the same result. Thus, I have examined the skull of a negro which reminded me of the appearance of an egg dropped from a height. The comminution was the most extensive that I have ever seen, and was the result of blows from the head of another

¹ Pyæmia more commonly follows contusion of bone than it does fracture.

negro, who had seized the victim by the lapel of his coat while he butted him. The skull would have been thin for that of a white man, and was singularly so for that of a colored one. Fissures of the surrounding, comparatively uninjured bones, not uncommonly coexist with comminuted fractures.

Indentation or fissuring of the outer table only, is occasionally met with, but, as a rule, even these slight injuries are accompanied by much more extensive splintering and depression of the inner table of the skull, as shown in Figs. 1075, 1076, from a specimen in the Mütter Museum. This result, which is observed in all fractures of the skull from direct force, is mainly due to the fact, pointed out by Teevan, that the bone yields first on the side of extension.¹ Thus let E F, in Fig. 1077, represents a segment

Fig. 1077.

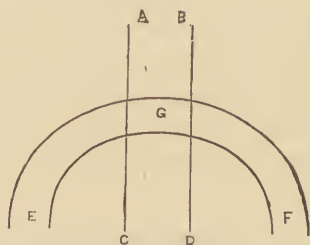
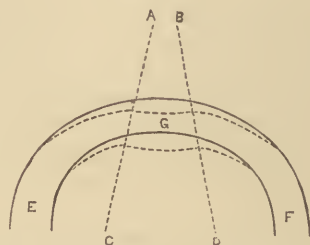


Fig. 1078.



Diagrams illustrating mechanism of fracture of the inner table of the skull. (After Teevan.)

of the calvaria, and the space G, included between the parallel lines, represent the portion of bone struck. The portion of bone G yields to the blow, to a much greater extent than the portions of bone E and F, which in consequence may be considered as practically unmoved. The result is that the osseous tissue of the upper, convex portion of G is much compressed, while the lower, concave surface tends to be straightened out, or extended, with a consequent rupture of the bony fibres, and, the force continuing to act through the medium of the compressed outer table and diploë, the fragments of the inner table are depressed, the points c and d being widely separated. (Fig. 1078.) Unquestionably, as stated, the bone thus yields first and most markedly upon the side of extension; and the want of support afforded by the soft cerebral mass, with the resiliency of the whole skull, causing its over-recoil, explains the relatively extensive depression of the inner table produced by comparatively slight blows. A glance at Fig. 1079 will explain this, as well

Fig. 1079.

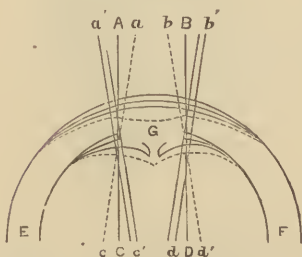


Diagram illustrating mechanism of fractures of skull.

as the mechanism of fractures of the internal table alone. The double lines represent the secondary positions assumed by the skull just after the force has ceased to act, the dotted lines the primary effects of the blow, and the single black lines the condition in which the parts finally remain. Hence it will be seen, that the fracture commencing upon the side of extension, the fragments of the inner table remain almost undisturbed in the position in which they were left by the blow, while the outer table regains its normal level, owing to the mutual compression of its component parts, and to the fact that

¹ British and Foreign Medico-Chirurgical Review, vol. xxvi. Teevan's paper deals with fractures of the internal table alone, but the mechanism is the same for complete fractures, and, with the modifications here suggested, his explanations will serve to elucidate certain points which otherwise would be obscure, and which have very commonly been erroneously interpreted.

the comparatively undisturbed surrounding bone serves as immovable abutments to the straightened arch. If there is a depression without actual fracture of the outer table as well as of the inner, the force has been such as, by partially crushing them, to overcome the resiliency of the bony fibres of the outer table and the diploë, and thus prevent restoration of the arch form. The truth of Teevan's views as to the bone yielding first on the side of extension, is proved by the fact that blows inflicted upon the *inner* table of the skull, will cause more extensive shattering of the outer table than of it.¹

A fissure of the outer table may be so slight as to escape close scrutiny, while the inner table has been extensively comminuted. After careful search in one instance, the fissuring would have been overlooked had it not been that a minute tuft of hair was imprisoned by the fissure when the impacting force made it gape widely. In a case reported by Dr. P. H. Watson, a tuft of hair was found in a portion of skull bared by what had been supposed to be only a scalp-injury, the fissure having been originally wide enough to allow the passage of a thin flake of lead from a passing ball, which was found, after trephining, lying upon the *dura mater*.² Fissured fractures are the only variety of such injuries which occur by *contrecoup*, or counter-stroke; they may be very extensive, separating the upper from the lower part of the skull, or its anterior from its posterior segment, by extending through the base.³

There is one portion of the vault where extensive splintering and depression may occur without any involvement of the inner table, and that is in the region of the frontal sinuses. As these cavities do not exist until at or after puberty, and do not attain oftentimes any great size until after twenty-five years of age, fractures of this region must be most carefully examined. Even in advanced adult age, the frontal sinus may exist only on one side, or there may be a large sinus on one side of the median line and only a minute one on the other. Again, the frontal sinuses may be large enough to lodge a musket-ball without injury to the inner table of the skull. Race has something to do with the development of these cells, which are peculiarly large in the full-blooded African.⁴

Fracture of the inner table of the skull is a very uncommon injury, and more often results from blows of glancing bullets⁵ than from the accidents incident to civil life. Still it may occur from blows by stones, sticks, or cricket balls, and the possibility should not be lost sight of, as the danger to life of these injuries is very great. In one case reported by Mr. Edwards,⁶ fatal intracranial hemorrhage occurred as the result of laceration of the middle meningeal artery by a scale of the inner table. The external table of the skull was intact. The mechanism by which these fractures are produced has been already explained. Fig. 1080, from a specimen kindly placed at my disposal by Dr. J. F. Holt, of Philadelphia, exhibits the appearances seen in such cases.

Although the broken fragments may remain at the same level with that of the healthy bone, they are generally upon a deeper plane, that is, are depressed. Still more rarely in civil life, the fragments may be *above* the level of the sound bone, as in a case reported by Hewett, where a chisel fell

¹ Loc. cit.

² Edinb. Med. Journal, July, 1870.

³ Sir A. Cooper, Lectures, ed. by Tyrrell, Am. ed., p. 131. 1839.

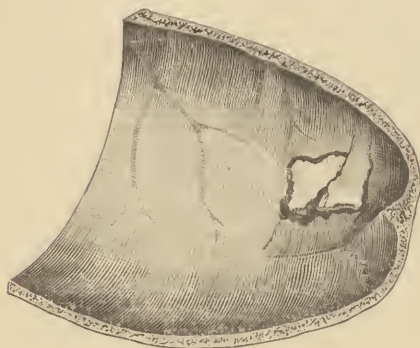
⁴ Hilton, Lectures on the Cranium.

⁵ Twenty such cases are reported in the Med. and Surg. History of the War of the Rebellion. See also Guthrie's Commentaries on the Surgery of War, 6th ed. p. 322, etc. 1862. Pott, Dease, Deane, S. Cooper, Weeds, and others, report cases. There is a well-marked specimen of this form of fracture in the Mütter Museum. Similar cases are also to be found in the works of Paré and other writers.

⁶ Edinb. Med. Journ., vol. viii. p. 191.

from a height, cutting and bending outwards a trapdoor fragment, including the whole thickness of the skull. In the Mütter Museum of the College of Physicians of Philadelphia, there is one specimen from a case in which a circular-saw accident elevated a large fragment, and another from one in

Fig. 1080.



Fracture of inner table of skull.

Fig. 1081.



Fracture of occipital bone by hatchet-wound.

which a blow from a hatchet did the same, but appears to have completely separated the fragment, which, sliding down, has become co-ossified there, leaving a permanent opening through the occipital bone. (Fig. 1081.) Sabre-cuts not uncommonly produce similar elevations of the broken bone.¹ "In the Museum of the Royal College of Surgeons there are ten skulls which have suffered from very severe slicing cuts. . . . The portions of bone thus sliced, and they are large pieces, were once detached, and afterwards reunited a little out of their proper places."²

Incised fractures, the result of cutting instruments, are, however, rare in civil practice, although cuts with hatchets, knives, and circular saws occasionally produce such injuries. Sword cuts, especially when the weapon is very sharp, may shave off a slice of bone involving only the outer table, as in a specimen in the Army Medical Museum, or they may penetrate no farther than the diploë, as in a case observed by Dr. F. H. Gross, of Philadelphia, where a shoemaker's knife stopped just short of the inner table. This fact should be borne in mind, as there may be no necessity for cutting through the whole thickness of the skull to remove imbedded fragments. When both tables of the skull are involved, especially in hatchet and axe wounds, the inner table is apt to be extensively comminuted and depressed in a linear manner. The only specimen with which I am familiar, showing an exception to this rule, is that of which I have already spoken, where the sword was evidently exceedingly sharp, and made a number of almost clean cuts, without any appreciable splintering of the inner table. A probe introduced sideways beneath the fragments will sometimes demonstrate this separation of the inner table by detecting its presence at a lower level.

Punctured fractures present two broad varieties, viz., those inflicted by sharp, and those inflicted by dull instruments. It will be seen that the distinction is not a superfluous one, when I explain that when the wound is made by a narrow, smooth, sharp instrument, such as a penknife-blade, there may not be the slightest splintering or depression of the inner table, if the instrument

¹ Cooper, op. cit., p. 132.

² Guthrie, op. cit., p. 362.

be driven in at right angles to the planes of both tables, while if it enter obliquely, there is apt to be merely a curling down, as it were, or at most a splitting off, of a small scale of the inner table; but that when the vulnerating

Fig. 1082.

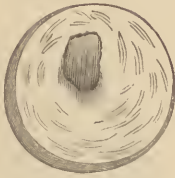
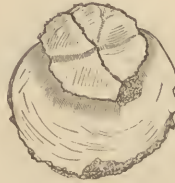


Fig. 1083.



Disk of bone removed by trephining, showing punctured fracture of skull. (From a specimen in the museum of the New York Hospital.)

The same as Fig. 1082 showing fracture of inner table.

body is dull, such as a piece of stick, a cane-ferule, the corner of a brick, or a blunt-pointed nail, the fragments of the outer table and diploë are carried in, wedging apart and extensively comminuting the inner table.

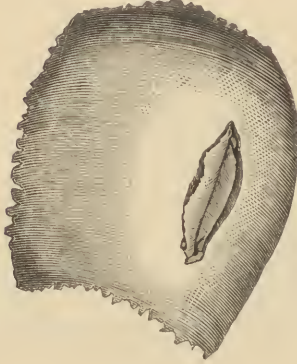
There is then a difference in the conditions of these two varieties of punctured wound, which explains the different course pursued by them in many instances. Penetrations of the skull, especially of the vault, by penknife-blades, fragments of glass, etc., may divide large branches of the meningeal artery and cause fatal hemorrhage.¹ It must not be thought that only pointed instruments can produce punctured fractures. The essentials, both mechanical and clinical, of a punctured fracture, consist in circumscribed injury of the outer portion of the skull, with extensive shattering of its inner table. Thus I have been compelled to trephine a young man who had broken his skull by a fall against the corner of a square iron nut. The injury to the outer table was most insignificant, while the inner table was broken up for a considerable extent into minute fragments, the number of which would never have been suspected by the uninitiated, from an inspection of the injury to the outer table. Sabre and hatchet cuts thus present all the essential peculiarities of punctured fractures.

Depressed fractures, involving both tables, present certain varieties of form which I shall now point out. One of the most common is that seen in the accompanying cuts from a specimen in the Mütter Museum. (Figs. 1084, 1085.) Here an ovoidal piece of bone, split into halves, has been driven down upon the brain. Owing to the longitudinal fissuring and firm impaction of the fragments in their slanting relation to one another, there must have been very marked pressure exerted upon the membranes and the brain; much more indeed than would appear at first sight possible, and more than occurs in other varieties of impacted fracture. This is commonly the result of the application of great force by a heavy body presenting a convex, rather sharp edge, such as a horse-shoe, the edge of a beer mug, a dull hatchet, etc. Sometimes a form of fracture is met with, consisting of a long, single fissure, with marked overriding of one margin of the fractured bone. The most common variety of depressed fracture, however, is that in which a more or less ovoidal portion of bone is broken into a number of triangular fragments, with their apices directed inwards towards the deepest portion of the depression. When most of the fragments are driven down to about the same level,

¹ See Fig. 1088, *infra*, for an illustration showing a wound of the meningeal artery by a fragment of glass.

firm impaction generally exists; and even where they occupy different planes, it is oftentimes a matter of surprise to observe how firmly they resist elevation, although further depression may be effected.

Fig. 1084.



Depressed fracture of outer table of skull.

Fig. 1085.



Fracture of inner table of skull. From same specimen as Fig. 1084.

In all depressed, comminuted fractures, the inner table is, as a rule, much more extensively shattered than the outer.

Bending of Bone without Fracture.—I do not believe that traumatic depression of the skull can occur in the adult without fracture. In the child, such an accident has been frequently reported, but as I have been unable to find any account of a post-mortem examination of such a case, I can neither affirm nor deny the fact that none of the bony fibres give way. I am inclined to think, however, that in the young child, before co-ossification of the different cranial bones has taken place, such an accident might occur, with simple rupture of a few of the fibres on the side of extension, but no fissuring of the bone.¹ The most curious distortions of the skull result from these bendings of the calvaria, which are apt to involve a large extent of such bones as the parietal, frontal, or occipital. No fracture can be detected, and the depression is smooth, and commonly ovoidal, although the late Professor Gross reported several cases where some of the normally convex portions of the skull were simply flattened, with exaggerated projection of the other segments. I have seen a long, linear depression, which resulted from a fall against the edge of a marble step. Sooner or later, generally within a few days, these depressions resume their normal level.

Intra-Uterine Fractures of the Skull.—Some authors teach that a blow upon the abdomen of a pregnant female may produce a cranial fracture, but do not bring forward any cases in support of this view. I am exceedingly skeptical of the accuracy of any such observations. Undoubtedly, in tedious labors, with a disproportion between the foetal head and the maternal bones—however caused—such accidents have been reported. Sometimes the arm has been interposed between the foetal head and the cranium, while at other times no assignable cause has been manifest. Occasionally the labor is neither tedious nor severe, and the pelvis may be of normal size. The parietals are the bones usually involved, or the parietal and frontal. Sometimes the occi-

¹ The result of examination of fractures occurring during unassisted labor would seem, however, to negative this view. See p. 21.

pital is broken, and most rarely of all the temporal. Depression is uncommon, the fracture consisting of one or more fissures, from half an inch to one and a half inches in length. Rarely there is marked depression, and cases have been reported where a spiculum of bone could be readily detected through the integument. This must, however, be an exceptional occurrence, as it is probable that a cephalhæmatoma invariably accompanies such injuries.

When not still-born, infants thus injured may recover, when any depression which exists will probably disappear in the course of time.

Diagnosis of Fractures of the Cranial Vault.—There are no certain signs by which we can determine the existence of a fissured vault, when no wound leads down to the bone; and in many cases a post-mortem examination first reveals an unsuspected fissure of the skull. Effusions of blood into the superjacent tissues have induced experienced surgeons to cut down upon supposed fractures, and no fracture has been declared to exist when the skull has really been broken. When lying beneath the temporal muscle, an extensively comminuted fracture may escape the closest examination. Gross relates a case where he was nearly led into error by a congenital malformation of the skull. I have myself been struck, in examining certain heads or skulls, to notice how readily a careless observer might mistake a depressed fontanelle, or one closed by a Wormian bone, for a depressed fracture. Bearing in mind these possibilities, a few inquiries as to the patient's previous history, and a proper examination of the anatomical relation of the parts, will secure against mistake. Absorption of the diploë, and consequent thinning of the skull, may likewise lead to errors of diagnosis.

Compound fractures of the vault are usually readily detected, but this is not always so, as in Dr. P. H. Watson's case, already referred to, where a few hairs, caught in the minute fissure, alone led to its recognition. I cannot agree with Sir Prescott Hewett, when he says that sutures and vascular grooves may be mistaken for fissured fractures even after careful examination, for there is one infallible test, viz., that the line of coagulated blood lying in an uninjured suture, or groove, can always be wiped away, while no amount of rubbing with the sponge will remove the line of blood effused between a fractured bone or separated suture. I have on more than one occasion satisfied myself of the truth of this very ancient observation.¹ Sometimes a line of coagulated blood beneath the edge of the adherent periosteum may appear like a fissure, but as this membrane can be pushed away, the absence of fissure at the site of the blood-line can be readily determined. Gross suggests that the cup-like depression of the outer table should be filled with water, when it cannot be determined whether or not the inner table is fractured as well as the outer. If only the latter be fissured, the water will remain, while if the inner table be also broken, the water will filter away between the fragments. I have never tried this expedient; and although the disappearance of the water would undoubtedly prove an injury of the inner table, its remaining might not disprove comminution of the vitreous layer of the skull.

A foreign body—as a piece of bone—having been driven through the temporal fascia beneath which it remains, may give rise to the erroneous diagnosis of a comminuted, depressed fracture, the margins of the firm fascia feeling like an opening through the bone. The error was in one case only corrected by observing that the supposed skull-fragment presented upon removal a

¹ Hippocrates recommends the application of a solution of the "jet black" ointment to detect fissuring of the skull. Celsus translates this "*atramentum scriptorum*," and the note to the Sydenham translation of Hippocrates's Works explains that this ink was made of the soot of pines and gum. It is this ancient suggestion, evidently, that has led to the significance of the line of coagulated blood in fissure of the bone being discerned.

white macerated appearance, and evidently was not a recently detached piece of human bone.¹

Depressed fractures in the region of the frontal sinuses may only involve the outer table. The error has been made of mistaking an exudation of inspissated mucus through a break of the anterior wall of the sinus, for an extrusion of cerebral matter. In these fractures the skin covering the fragments may become emphysematous, especially if the patient blow his nose violently. When emphysema is detected, it plainly indicates the presence of a fracture which at least involves the anterior wall of the frontal sinus.

Prognosis.—This being almost entirely dependent upon the concomitant cerebral lesions and their sequelæ, is uncertain. Linear fractures, with neither depression nor symptoms of compression, usually do well, especially when they are simple. Sometimes, however, such cases are followed by suppuration between the bone and dura mater, though compound fissured fractures of the skull are more apt to be thus complicated. In any event such an occurrence is rare. The course pursued by the case is then similar to that of one of contusion of the skull, under which heading the reader will find the subject fully treated of.² The region of the vault affected also affords grounds for prognosis. Thus injuries of the anterior half of the parietal bone are apt to be followed by serious motor disturbances. Depressed fractures, simple or compound, are grave in proportion to the accompanying cerebral symptoms, and when these are absent throughout the course of the case, to the form of the injury. When the depression is slight, smooth, and uniform, the much dreaded secondary results, such as epilepsy and so forth, are far less liable to occur than when the displaced bone is broken into many irregular fragments, which press deeply into, or even penetrate, the brain. These remarks are equally applicable in regard to the chances of encephalitis, although of course no absolute rule can here be laid down, since there may be severe contusion or laceration of the brain with but little primary indication of such an accident, and since with but slight injury to the outer table, the inner table may be much comminuted. Punctured fractures are exceedingly dangerous, and in most cases, when unrelieved by operation, prove rapidly fatal. In this class I would include all fractures which consist of a limited injury of the outer table with extensive shattering of the inner, such as those produced by the corner of a brick, a sword-cut, blows with hammers, pokers, or hatchets.

Although a compound fracture presents some features of gravity that a simple one does not, yet the free drainage, preventing accumulation of inflammatory exudates, and the more probable circumscription both of bone and of brain injury, in many cases do away with much of the apparent difference, and with modern antiseptic precautions the prognosis is materially improved. One of the chief additional risks, putting aside pyæmia, is from hernia cerebri following primary laceration or sloughing of the dura mater. The increased chances of encephalitis from the admission of air, are much lessened by antiseptic precautions, yet they undoubtedly exist. Finally, let me again reiterate that the one great danger to be apprehended is encephalitis, and that, were it not for this, patients with fractures of the cranial vault would convalesce almost as certainly as those with fractures elsewhere. But a clear distinction must be drawn between the encephalitis necessarily resulting from the primary injury, which is unavoidable, and the encephalitis resulting from the pressure upon, and irritation of, the intracranial contents by fragments of bone, which the normal, pulsatory movements of the brain render remarkably efficient as constant sources of irritation.

¹ Hewett, op. cit., vol. i. p. 582.

² See page 8, *supra*.

Treatment.—From the preceding remarks, it is clear that the surgeon's main attention should be directed not to the broken skull, but to the injured brain. Encephalitis results, first, from injury done to the brain and membranes by the fracturing force and the bony fragments. Granted a certain amount of intracranial injury, and inflammation must ensue; but in many cases this unavoidable result can be conducted to a favorable termination by antiphlogistic regimen, and treatment such as was advised for concussion and laceration of the brain. I am desirous of emphasizing the fact that there is a form of encephalitis after fracture of the skull, similar to that met with after head injuries where no bone lesion has resulted, which is inevitable, despite any treatment addressed to the fracture, and which can be combated by general measures alone. At the other extreme, there are cases where the intracranial injury is so slight as to result, *of itself*, in little further trouble, but such cases prove fatal from the constant "fretting" of the brain and its membranes by displaced fragments of bone. The only proper treatment for these cases manifestly is to remove the source of irritation, and with it almost the only cause of inflammatory mischief. In the first class of cases, as elevation of fragments cannot remove precedent injury of the brain, such a procedure only proves useful by preventing secondary inflammation due to the irritation of bony spicula. To this class belong most of the fatal cases of primary trephining, where the operation is wrongly tabulated in statistical tables as fatal; the fact being that the operation, being incapable of restoring a lacerated, ruined brain, merely fails to do any good. But there is an intermediate variety, where the meningeal and cerebral injuries are not necessarily fatal in themselves, but are rendered so by the sloughing and inflammation—perhaps avoidable—which are rendered certain by leaving depressed, lacerating fragments of bone, goading the tissues; patients thus hurt may recover under the effect of rest, with removal of every source of irritation. Here extraction or elevation of the depressed fragments of bone, with appropriate general treatment, is clearly indicated.¹

Non-penetrating incised wounds must be treated as cases of contusion of bone, after careful removal of any foreign substances, such as, for instance, the point of a knife-blade. When a portion of the calvaria has been sliced off, carrying with it a broad-based scalp-flap, according to most authorities it may be safely turned back, and will probably adhere, provided that free drainage be secured.² When the fragment does not seem firmly connected with the scalp, or when the flap-pedicle is narrow, the bone had better be dissected out, and the case then treated as one of compound fracture with loss of bone.

Fissures of the skull, simple or compound, do not call for surgical interference unless symptoms of compression from extravasated blood, or at a later period from intra-cranial suppuration, call for operation.

In compound depressed fractures, unless the fragments are very slightly depressed, the bone should be elevated. Such cases, when left to nature, must be watched with the utmost care, for even when the outer table seems merely bent down in the centre, with capillary fissuring of the margins of the depression, extensive shattering of the inner table may exist. (Figs. 1086, 1087.) In compound, comminuted, depressed fractures, the surgeon should, in my judgment, always operate at once, to prevent intracranial inflammation: in other words, "preventive trephining" should be resorted to. To wait until symptoms of trouble arise, is to wait until operation can rarely be of any

¹ See sections on Concussion and Contusion of the Brain, and on Encephalitis.

² Larrey reports a case where, after replacement of the bone, serious cerebral symptoms arose which compelled him to dissect out the fragment, when recovery took place. In another case he was not so fortunate, death following.

service. Such practice is illogical and opposed to the results of experience. When such cases prove fatal from trephining, they do so from concomitant lesions, not from the operation, if properly performed.

Fig. 1086.

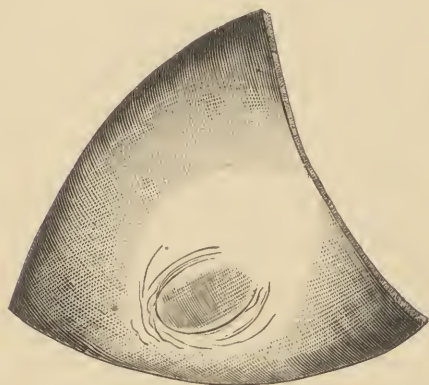
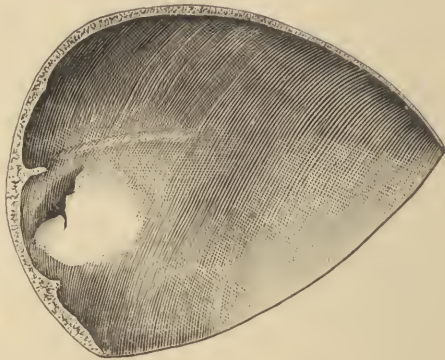


Fig. 1087.



Fracture of skull with shattering of internal table. (From a specimen in the Mütter Museum.)

I shall not enter upon the vexed question, whether or not depressed bone produces cerebral compression, as I do not found my advice upon the existence of such symptoms. Besides, experience shows that in many a case in which the patient has been thought to be suffering from compression by depressed bone, the symptoms have really been due to effused blood, which has been successfully removed. Any theoretical views which tend, therefore, to cast doubt upon the possibility of compression resulting from displaced bone (an occurrence which, however rare, has unquestionably been met with),¹ are mischievous, as apt to restrain the elevation of depressed portions of the skull beneath which effused blood or pus may lie. There is one important occasional exception to this rule. When a depressed fracture takes place in the adult over the region of the frontal sinuses, there may oftentimes be an extensive indriving of bone, with no injury to the brain. If, after careful examination, there are good grounds for believing that the inner table of the skull is uninjured, it is advisable to wait, remembering that upon the first symptoms of meningeal irritation an exploratory operation must be performed, and the fragments elevated should any be found depressed.

The surgeon should not await compression-symptoms as an indication for operation in fractures of the vault, as then it often will be too late. Undoubtedly many patients recover in whom the bone is not elevated,² but in too many epilepsy, insanity, chronic cerebral irritation, etc., render life a burden, and operations are then required which often prove useless. Modern investigation and experience show most clearly the danger of leaving depressed fragments of the skull *in situ*. Operations for epilepsy show at times that, in the effort to bridge across the irregular fragments, and from the constant irritation due to the cerebral pulsation, driving the dura mater

¹ See Sir Astley Cooper's account of Mr. Cline's famous case. (Op. cit., p. 138.) Other cases, quite as conclusive but not as striking, could be cited.

² Hennen relates a case "where the man survived thirteen years, with no other inconvenience than occasional determination of blood to the head on hard drinking," and yet there was "a funnel-like depression," one and a half inches deep, "in the vertex." (Op. cit., under Case XXXIX.)

against the bony fragments, nature throws out osteophytic growths which eventually—perhaps after years—set up serious trouble.¹

For manifest reasons, punctured fractures of every variety should at once be operated upon, every fragment being carefully elevated or removed. In certain cases of extensive hatchet-wound, where the use of the trephine would result in the removal of too much of the calvaria, and where consequently the case would otherwise have to be left chiefly to nature, Hey's saw may be used to remove a strip of bone upon either side of the wound.²

Fractures of the inner table, being unrecognizable by any definite symptom, are not usually detected except after death. The possibility of such an injury being caused by concentrated, violent force, such as a blow from a glancing bullet, from a pebble, etc., will in otherwise obscure cases, when secondary symptoms of compression arise, warrant the application of the trephine at the point of impact³—a mode of practice which has occasionally proved successful.⁴

And now what shall be done for depressed, simple fractures? This is the most difficult to decide of all the questions relating to head surgery. In giving the advice I do, I fully feel the serious responsibility that I am assuming. Still, I think that it is both theoretically correct, and, still better, warranted by experience.

In simple depressed fracture, the chief removable primary danger is encephalitis from the irritation of depressed fragments. In such cases if our medical measures fail, the patient can only die, but if he lives without elevation of the depressed portion of bone, a miserable life is too often before him, with chronic cerebral irritation, epilepsy, fatuity, insanity, or even murderous impulses. What shall be done in these doubtful cases?

If the untoward results just described were very unusual, or if the fear expressed of converting a simple into a compound fracture, which after all is the only valid ground of objection against elevation of the bone, were well founded, there could be no question as to the advisability of non-interference. But I contend that the dangers of a simple, depressed, comminuted fracture are greater than those which follow its conversion into a compound fracture. With the knowledge which we now possess of the great probability that sooner or later nearly every case of depressed skull-fracture will result in epilepsy, or in some form of secondary brain-disease, and since reliable statistics show that trephining itself is not a more dangerous operation than those commonly resorted to in other affections, in order to avert possible dangers less grave than those entailed by depressed fragments of bone, I cannot but think that, with the restrictions which I shall presently point out, it is our duty to advise elevation of a simple, depressed, comminuted fracture of the skull. I think that the opinion which I have expressed is steadily gaining favor among surgeons, and I feel emboldened to express my views by the published opinions of such distinguished and experienced operators as the late Prof. S. D. Gross, and Prof. Moses Gunn, of Chicago.

This return to the practice of our ancestors is more an apparent than real departure from that of the present day. Most surgeons would, I presume, agree with Hewett, when he says that, where the symptoms "are urgent—if they indicate a decided pressure upon the brain—then operative interference becomes necessary." I would simply go one step further and say that to

¹ Dudley reports a case of epilepsy supervening nine years after the fracture. Operation in this case proved curative. Sir A. Cooper (op. cit., p. 137) also relates an instructive case.

² Hey, *Practical Observations in Surgery*, page 19. Philadelphia, 1805.

³ Teevan shows that fracture of the inner table always occurs opposite to the point struck. (Loc. cit.)

⁴ See page 12, *supra*, for a recovery occurring after trephining, in the practice of Prof. Hughes.

prevent secondary inflammation and late brain-disease, I would operate at once in badly depressed, comminuted, simple fractures, even though they presented no decided symptoms of compression. When, however, the fracture is not extensive, only slightly depressed, and but little comminuted, a primary operation should not be thought of, unless marked symptoms of compression are present. In these cases a little delay may prove that apparent compression is due to slight concussion, etc. General treatment must be relied on, and the strictest watch must be kept for symptoms which are indicative of subcranial suppuration, upon the supervention of which, according to the principles enunciated in a former portion of this article, trephining should at once be performed. If, however, the bone be much depressed and extensively comminuted, so as to press upon and injure the membranes and brain, the margins of the cranial opening being irregular and jagged, an incision should be made, and the case treated as one primarily compound. I consider this to be the best practice, even when no symptoms of compression are present; and of course an operation is still more imperatively demanded when pronounced compression of the brain exists. In all these cases, it is presupposed that the surgeon has arrived at the conclusion that the apparent pressure-symptoms are most probably due either to the depressed bone or to intracranial hemorrhage, and not to diffused injury of the brain.

With careful antiseptic dressings, the minimum of risk results from thus converting simple into compound fractures.

With children, especially very young ones, a different course must be pursued. In many cases there is mere bending, or at least insignificant fracture of the bone. There being no diploë, or at least very little, if the outer table be not comminuted, the inner cannot be much shattered. At what age the skull of a child approaches that of an adult in its behavior when subjected to a fracturing force, I cannot say, but I am convinced that in children under two, and often up to three years of age, the observations just made hold good.

In simple, depressed fractures in children, the bone will either spontaneously resume its level, if recovery ensue, or it may be raised by pneumatic suction if the bones are yielding, as in two cases mentioned by Prof. Gross.¹

Dr. W. L. Moultrie, of Charleston, S. C., in 1849, had a patient aged five months, with a depression of one parietal bone large enough to contain the bowl of a tablespoon. A cupping-glass having been adjusted and exhausted of air, traction was made upon it with the effect of rapid and complete restoration of the entire surface to its natural level.

A case of a similar nature, in a child two years of age, has been reported by Dr. Nicolls.² The depression, a deep narrow one about three inches in length, was promptly raised by a cupping-glass placed upon an embankment of common glazier's putty, in order to afford it a proper purchase.

Complications and Sequelæ.—Encephalitis from brain injury, and intracranial hemorrhage in all its forms, are the chief complications. Pyæmia is rare after fractures of the vault, although it may occur. The great sinuses may be wounded, and the formation of a thrombus, and purulent infection, may follow. Brain-abscess is a not uncommon sequel. The cicatrix formed where there is loss of bone-substance, may in very rare instances be ruptured, hernia cerebri and death ensuing, as in a case reported by Jamieson, where the accident resulted from the violent paroxysms of coughing incident to an attack of whooping-cough.³ The rent, however, may close, and recovery take place.⁴

¹ Op. cit., vol. ii. p. 64.

² Dublin Med. Press, Sept. 1853.

³ Med. Essays and Observations (Edinburgh), vol. ii. p. 217.

⁴ See Holmes's System of Surgery, vol. i. p. 585.

Where there has been a loss of bone, the gap is usually bridged across only by a dense membrane, into which, however, ossification may sometimes extend for some little distance.¹

II. FRACTURES OF THE BASE OF THE SKULL.—Basal fractures may result from either direct or indirect force. Among forms of *direct* violence may be enumerated (1) thrust wounds, by walking-canes, sticks, swords, bayonets, etc., which penetrate the skull through the roof of the orbit or of the nose; (2) a blow upon the chin, which may actually drive one condyle of the jaw through the glenoid fossa; (3) a blow upon the nose, which, fracturing the bones of that part, may likewise shatter the cribriform plate of the ethmoid, as is shown in two specimens in the Mütter Museum.

Thrust wounds most commonly implicate the thin walls of the orbit, the cribriform plate of the ethmoid, the fragile, shell-like body of the sphenoid, and more rarely the occipital bone. Such accidents can readily occur in the roof of the orbit, through which the brain may receive fatal and unsuspected injury, since the vulnerating body may have passed through the retro-tarsal fold of the conjunctiva,² producing merely an ecchymotic patch on that membrane; or there may be so small a skin wound that, seeing the vulnerating body to be large, the surgeon may think that not even a penetrating wound of the skin has taken place.³ In such cases there are probably no brain symptoms for several days, after which they develop sometimes quite suddenly, death resulting, perhaps, in a few hours; or the case may run a longer course.⁴

Murderous wounds, which leave no trace that can be detected except after most careful examination, may also be readily effected by passing a small pointed instrument through the retro-tarsal conjunctival fold, and then penetrating the delicate orbital roof and superjacent brain. This is especially easy in the case of children, but presents no great difficulty even in the adult. The medico-legal bearing of this fact is plain.

Prognosis of Basal Fractures from Direct Violence.—Death is the usual result of these fractures, the autopsy first revealing the nature and full extent of the injury. More rarely recovery has ensued, as in one case where the severe brain symptoms left no doubt of the nature of the injury, and in another⁵ where brain protrusion occurred.⁶

Treatment.—The prospects are very bad should any foreign body be left within the skull. An exceedingly instructive case related by Hulke⁷ I shall here quote, as it indicates a somewhat important point in practice.

A girl, aged six years, received a punctured wound of the orbit from falling upon a slate pencil which she was holding in her hand. All portions, as was supposed, of the slate pencil were removed by the house surgeon, and the child passed a comfortable night. The next afternoon, when Mr. Hulke first saw her, he detected with the probe a portion of the pencil deep in the wound, enlarging which he exposed the fragment

¹ There is a specimen illustrating this in the New York Hospital Museum. (No. 24.)

² A case of this nature has been reported by Sir A. Cooper, where a pair of scissors penetrated the retro-tarsal fold, with no brain-symptoms resulting for over four days. (Lectures, edited by Tyrrell, Am. ed., p. 131. 1839.) See cases by Sir P. Crampton and J. Paynter, Dublin Quarterly Journal of Medical Science. 1851.

³ Morgagni, De sed. et caus. morborum, Epist. li. Sect. 58.

⁴ Paynter's case, already cited. J. H. Jackson, in the Lancet for Feb. 2, 1884, reports a case of punctured wound of the orbit from a blunt piece of stick, which wounded the lateral ventricle. The stick passed between the inner canthus and the eyeball, leaving only a slight ecchymosis. There were no cerebral symptoms until the fourth day, when they were suddenly developed, death taking place in a few hours.

⁵ Morgagni, op. cit., Epist. li.

⁶ Lancet, vol. ii. p. 16. 1837-38.

⁷ Holmes's System of Surgery, vol. i. p. 586.

wedged in an opening in the skull. Sufficient of the latter was cut away with the gouge to admit of the removal by the forceps of what was again supposed to be the whole of the foreign body, which proved to be shattered. Encephalitis set in, with high temperature and rapid pulse, until the ninth day, when, after a quiet night, the temperature fell to 97.5° F., and continued subnormal until the sixteenth day, when it suddenly rose to 104° F. Restlessness, delirium, flushed face, screaming, vomiting, convulsions, and coma accompanied this high temperature. Death took place in twenty-four hours, and the post-mortem examination revealed a large abscess of the right frontal lobe, which had recently burst into the anterior horn of the lateral ventricle. In the abscess lay a piece of pencil one inch long.

Mr. Hulke goes on to say, that, "Cutting away the bone by the gouge effected such a loosening of the splinters of the pencil as to result in a fragment being left behind;" and he expresses regret that a trephine had not been used instead of the gouge. To this latter point of treatment I would call particular attention, viz., the use of the trephine to remove foreign bodies imbedded in the skull, since by it the end in view can be most easily attained, the whole extent of the injury revealed, and removal of all shattered bone, foreign bodies, etc., readily secured. In other respects, the treatment is the same as that for other severe, penetrating head-injuries, which has already been sufficiently described.

The same misleading appearances of the external wound may be present in thrust wounds of the nose. Thus Dr. George Anderson¹ reports a case where, while fencing with walking canes, a man was struck a blow upon the left ala of the nose, which produced a small puncture not larger than a leech-bite. Dying a few days afterwards with evident, acute brain disease, post-mortem examination revealed the brass ferule of a cane, lying close to the left side of the sella turcica, having reached this position by penetrating the body of the sphenoid bone. Although examined by a surgeon shortly after the accident, the nature of the injury was unsuspected.

Fractures of the glenoid fossa from blows upon the chin have been reported. Sir Prescott Hewett gives a drawing of one such case from a specimen. Dr. Lefèvre (de Rochfort) reports the case of a man, aged 22 years, in whom the right maxillary condyle was driven through the glenoid fossa into the skull, by a fall from a great height upon the chin. The patient lived over five months, presenting no other symptoms than pains in the head, and some mental peculiarities which were thought to be simulated until an autopsy revealed the nature of the injury. Then a cerebral abscess, due to the pressure of the maxillary condyle, was found situated at the under surface of the right middle lobe of the brain.²

Besides such instances of direct violence, there are others in which, as long since pointed out by David³ for other parts of the body, it is in reality the fracturing force. Suppose that a man falls from a great height upon his feet or buttocks; what results? Why, practically the condyles of his occipital bone are struck violently through the medium of the spinal column—struck just as directly for mechanical purposes as if with a sledge-hammer. Again, a man falls from a height and strikes full upon the vault in some comparatively yielding substance, such as soft earth. The weight of the body again strikes, through the medium of the spine, a violent blow upon the occipital condyles, thus fracturing them. The fact that such injuries are due to direct force may appear clearer when I say that a blow is merely

¹ Dublin Quarterly Journal of Medical Science. 1851.

² Gazette Hebdomadaire. Septembre, 1834.

³ In his well-known Prize Essay, published in the name of his pupil, Bazille (Prix de l'Académie Royale de Chirurgie, tome iv. p. 420. Paris, 1819). See, also, the same translated in Justamond's Surgical Tracts, edited by Houlston, page 239. London, 1789.

the exciter of vibrations, and that we must consider the point whence they start as in reality the point of impact.

Aran has pointed out that the curved and elastic spine, by its recoil, increases the violence of the shock in such falls as I have just described.

General crushes, where the head is caught between two opposing forces, fracturing the base as well as other portions of the skull, are also clearly fractures by direct force. Sometimes, where the head is thus compressed, the central bones of the base may be the only ones broken.

Fractures of the base may result from extension of fissures of the vault into the base, the "fracture by irradiation" of Fano.

Finally, basal fractures may result from conduction and amplification of vibrations, or by *counter-stroke* (*contre-coup*), as it is commonly called. This form of fracture very rarely occurs alone, but is an efficient factor in certain instances of the preceding class. If by a fracture by counter-stroke, one directly opposite to the point struck is meant, this probably never occurs except when the centre of the vertex is the point of impact. For instance, a violent blow upon the right parietal boss will not produce a fracture at the left parietal eminence, but at the base of the cranium, through one or both petrous bones. The statement commonly made that the vibrations which are excited in the vault travel by the shortest route to the base, is incorrect. The majority reach the base by the "shortest anatomical route," indeed, but that is very different from the shortest route. Again, the opinion expressed by a recent writer, that when the petrous bones are broken from a fall upon the occiput, this is because the "basilar process rests against the apices of the petrous bones" is both an anatomical and mechanical error. These mistakes arise from failing to remember that the various portions of the skull are of varying thickness, and are so constructed for specific ends. If the vault were of even thickness and density, as well as all of the base except its central portions, and if the skull were also a true sphere, then true fracture by counter-stroke might occur; for the vibrations would travel in all directions until—being probably of unequal velocity—when they met at the weak, central, basal portion, it would be disrupted. But the skull is of unequal thickness in different parts; it is not a true sphere; and certain portions of its base, although frequently broken, are in reality the densest and strongest.

It is unquestionably true, that the portion of the skull struck, determines which of the fossæ of the cranial base the fracture will probably traverse, when the fracture is not a severe one.¹ This I hope to explain by certain anatomical peculiarities of skull structure. The theory that vibrations of the brain produce fractures of the orbital plates, is too manifestly untenable to demand refutation.

I need hardly say that the force of the vibrations is directly proportioned to the amount of tissue set in motion. Let any one attempt to hold a heavy iron bar by one end, while the other, lying on an anvil, is struck a powerful blow with a sledge hammer: I think that in most cases the vibrations would force the unprepared hand open, and the bar would fall. Yet, if instead of the large bar a fine wire were substituted, and struck with precisely the same force, probably no vibration would be felt, although vibratory waves would undoubtedly be set in motion in the wire. In like manner, where the skull is thin, the vibrations are almost imperceptible; where thick they are marked. When the vibrations, starting in the thinner portions, reach

¹ In 25 cases analyzed by Hewett, the fracture was limited to one fossa, as follows: the anterior fossa in 5 cases, the middle in 14 cases, and the posterior in 6 instances: of 29 cases in which two of the fossæ were implicated, in 14 the middle and anterior fossæ were fractured, and in 15 the middle and posterior. In 10 out of 64 cases all three fossæ were involved. The middle fossa was fractured in fifty-three of the sixty-four cases examined.

the thicker, the latter, besides being better conductors of vibration, are actually *amplifiers* of the same.

The base must be massive, at least in parts, in order to support the superincumbent weight of the skull and brain, and to afford a firm basis for the movements of the lower jaw, and of the head on the spine, as well as to protect the important nervous structures in relation with it. While this arrangement is advantageous in health, there are compensating disadvantages when man is subjected to violence; indeed, in his ordinary movements this massiveness of portions of his cranial base would be disadvantageous, were it not for certain wise provisions to be presently mentioned. The pericranium without, and the dura mater within, act precisely as a wet wash-leather covering and lining would to a bell, damping vibrations. To the ovoid form of the skull, a large part of the security of the brain is attributed, and to a considerable extent this is true; but one important point is almost universally ignored by writers upon this subject. Endless demonstrations exist, going to prove that any segment of the brain-case is a section of a spheroid, and to this fact the immunity from fracture enjoyed by the skull is attributed. If fractures were produced only by crushing forces, the proposition would be incontrovertible. If however a large part of the damage is done by setting up vibrations in the bones themselves, then the form of the skull only conduces in a slight degree to its immunity from fracture. An arch that will sustain hundreds of tons of pressure, if vibrations are set up in it may readily be fissured, although its form may remain unchanged.¹ The arched form of the skull then merely resists the tendency of the bones to be pressed inward when a blow is struck, and, the vault not breaking, the force expends itself in producing vibrations which cause a basal fracture. Any brittle body will thus be injured whenever the vibrations become violent enough to overcome the cohesion between the particles composing that body. Examining the anatomy of a child's skull will give some useful hints. Probably no young child's skull has ever been fractured by a diffused blow upon the vertex, nor has more than one bone of the vault been broken, unless the force has been actually applied to it. Why is this? In an infant's skull every bone is isolated from every other by membrane, than which there is no better arrester of vibrations. An attentive examination of a parietal or frontal bone,² will show that the most projecting portions (those most liable to first strike the ground in falling) are the thickest, while extending from these centres are radii of bone becoming more and more delicate. Each of the fine terminal points of these radii is enveloped by membrane. The vibrations initiated by a blow upon the thicker, central part of the bone are conducted on, or rather have to be propagated, by a gradually thinning structure, that is, one less and less capable of vibrating strongly, until they finally reach the terminal radii of bone which are completely enveloped in membrane, when they are totally arrested. Hence it is that the lines of fracture of an infant's skull never pass beyond the one bone struck. Certain well-known clinical facts are thus explained by the anatomy of the child's skull. As the bones come to be more and more in bony contact, with advancing years, this immunity from radiation of lines of fracture from the point struck is gradually lost.

In the adult skull, the parietal bones and the frontal eminences, instead of being the thickest, are often the thinnest portions of the vault, and the eight component bones of the brain-case are more or less co-ossified, or at

¹ Basal fractures are practically always fissured, the form of the base remaining unaltered.

² The arrangement mentioned can best be seen in a fetal bone, but exists, although not so easily detected, long after birth.

least are practically in bony contact. The brain, which fitted fairly well the comparatively smooth base of the child's skull, has now apparently to lie upon a number of irregular and often sharp bony projections, which, to any one examining a fresh brain and a dry skull, would appear to render the brain liable to serious laceration from the slightest jar of the body, while a jump from the height of a few feet would seem to render disorganization of the base of the brain inevitable.

The mechanical effect of the diploë must now be examined. This is normally absent in certain parts, such as the cerebellar fossæ, the greater part of the squamous portions of the temporal bones, the orbital plates of the frontal, and the floors of the lateral sinuses as they approach the base of the brain. It may also be exceptionally absent in any portion of the vault. A blow upon the vault will set up vibrations of the outer table, which are transmitted to the inner, with much decrease in force by the damping effect of the diploë. The inner table is both a better conductor of vibrations, and also an amplifier of them. Wherever the diploë is present, the vibrations of the two tables pass along to certain denser portions of the skull, which externally are covered with muscle, internally by dura mater and cerebro-spinal fluid, where the waves of motion cease. But when, provided that they are of sufficient violence, they reach a portion of skull where the diploë is absent—just as where the insulating medium is removed between portions of an electric circuit, the spark leaps across, and a “shock” results—so the vibratory waves of differing intensity meet where the two tables become continuous, and a fracture takes place.

But all know that, upon the whole, the brain is the best protected portion of the body. Ignoring many intrinsic provisions for safety, we shall find that, in the fresh skull, the numerous projecting points of the base, instead of endangering the brain, actually protect it. In truth, these projections no longer exist—being covered by dura mater, and rounded off or overlaid by the great venous sinuses and bloodvessels of the part, especially where the greatest dissimilarity would seem to exist between the brain and its case, viz., at the central portion of the base. In addition, at these points the brain is lifted off from the skull by a “water-bed” of cerebro-spinal fluid. Did space permit, I could demonstrate that, where peculiarly dense portions of the skull are in contact with the brain or other bones, cartilage, sinuses, or arteries—that is, membranous tubes filled with fluid, the best possible arresters of vibrations—are interposed. Suffice it to say, that wherever needed such arrangements exist, so that those vibrations, excited in walking, etc., which do not neutralize one another, are safely conducted off to be “damped” by membrane and fluid.

Holding the base of a skull up to the light, the more massive portions will be seen to converge, in general terms, towards the petrous portions of the temporal bones, the anterior and posterior clinoid processes, and the crista galli of the ethmoid. The anterior and posterior clinoid processes, and the crista galli, are thickly enveloped in membrane and immersed in cerebro-spinal fluid. The apex of the petrous bones, and a portion of their inner margins, seem, the former in contact with the sphenoidal body, the latter with the basilar process of the occipital bone. In reality, the apex of the petrous bone is separated from the body of the sphenoid by the plate of cartilaginous tissue which fills the foramen lacerum medium, and by the carotid artery, while the inferior petrosal sinus lies in a groove formed partly by the petrous bone, partly by the basilar process of the occipital bone. Any well-informed anatomist can readily fill in this outline sketch of cranial anatomy. Now set in vibration the skull walls, and what results? The vibrations, indeed, reach the base, but only by the anatomical routes, the nearest preferably, but by all if the blow be sufficiently violent.

I think, then, that a little reflection will convince every reader, that the apparently useless and dangerous projections seen in the dried skull, do not exist in the normal state, but, being specially arranged, serve as the discharge-points for the vibrations which, by mechanical laws, must pass along the best conductors, that is, the densest portions of the bones, while these same conductors are also amplifiers of the vibrations. Physiological vibrations actually serve useful purposes, which I cannot here detail.¹

The foregoing facts would indicate that Aran and others are wrong in stating that fracture of the base is always accompanied by fissuring of the vault, which is the starting-point of the fracture. If, this were true, the greatest force being applied to the weakest portion, the fissures should be widest apart at that point, becoming finer and less widely separated as they reach the stronger portions of the base, but the reverse obtains, and, whether starting in the vault—which I admit is very often the case—or not, the amplification of the vibrations increases the shattering of the base. In slighter basal fractures the vault is not fissured, and even Hewett and Aran confess that the posterior clinoid processes may be broken off, or the roofs of the orbits fissured, without any line of fracture directly reaching them. If, therefore, slight fractures of the base do occur without fissuring of the vault, severer ones, where the vault is injured, may be similarly produced. The separation of the basal sutures shown in a case which I have elsewhere reported, and two specimens in the Mütter Museum, show that it would be impossible to produce the appearances presented if the fracture started in the vault; for then the upper continuation of the sutures would have been most widely separated. The suture could only have been separated as it was, had the fracture started in the vault, by some of the dentations being broken so as to drive one bone below the level of the other. Nothing of this sort was detected; but vibrations acting most forcibly on the base, would force apart the masto-occipital suture as if from within, and would cause precisely the appearances actually seen.

Examining basal contusions of the brain, we shall find that they demonstrate this conduction of vibrations to certain points of the base of the skull. The middle lobes of the cerebrum are most often bruised, next come the anterior, and finally the posterior, "which," says Hewett, "owe their immunity to lying upon the tentorium, while the others are injured by the sharp, irregular projections of the cranial base, which, although rounded off to a certain extent, and smoothed down by the dura mater, are still both sharp and numerous." Now as contusions are frequently found in various portions of the brain without fracture, and as even in basal fractures the bones are very rarely displaced, the only explanation, especially in contusions of the middle lobes, is to consider them as resulting from the conduction to that point of powerful vibrations.

No one who remembers what is really seen in post-mortem examinations of the brain-case, will accept the statement of "sharp, bony projections;" especially when it is borne in mind that the sinuses and bloodvessels are tensely filled with fluid blood during life.

As the occipital condyles often present two separate facets, if the head be extended when a blow is inflicted upon it, or during a fall upon the feet, the force will affect chiefly the posterior facets, while, if the head be flexed, the anterior ones bear the brunt.² This goes far to explain, always subject to the

¹ For details, see Hilton's Lectures upon the Cranium, Guy's Hospital Reports, 2d series, vol. viii., p. 351; also a paper by the author, Phila. Med. Times, Oct. 23, 1880.

² H. Allen has laid special stress upon the position of the head as determining the portion of the base broken.

laws governing vibrations, why in one case a fall upon the feet, knees, or buttocks, produces a fracture of the anterior, and in another a fissuring of the posterior fosse. Such cases as a fracture of only the cribriform plate of the ethmoid by a fall upon the feet, are thus explicable by the conduction and amplification of vibrations, the motion-waves being directed almost solely forwards, owing to the peculiar position of the occipital condyles as just described.¹ In the same way, fractures of the apex of the petrous bone and both posterior clinoid processes,² and fractures of the petrous bone and side of the sella turcica,³ with no injury in any instance of the occipital bone through which the force is transmitted, demonstrate beyond doubt the theory of conduction and amplification of vibrations.⁴ [See page 110.]

The following case, in which the injury was so trivial that it produced no symptoms of any moment, in which the contusion of brain-substance, if any, was at a minimum, and in which no inflammatory symptoms were present, suggests conclusions which I think go far to explain the fatality of basal fractures.

Dr. Charles Wirgman requested me to see with him a young lad who had fallen upon his head when playing leapfrog, but who had walked home with his comrade's assistance, immediately after the injury. When Dr. Wirgman first saw him, slight symptoms of concussion were noted. Next day he seemed better, only complaining of some pain in the head. Upon the third day the improvement was very marked, nothing remaining but a little headache. He begged to be allowed to sit at the window, and, notwithstanding the doctor's injunctions, walked about the apartment, and went to the yard to evacuate his bowels. A few hours after Dr. Wirgman's last visit, he was hastily summoned, and on his way called for me. Upon our arrival we were informed that the patient had suddenly been attacked with vomiting, and that eclampsia and death had almost at once ensued. Post-mortem examination revealed an insignificant ecchymosis over the right mastoid region, the result of infiltration of blood from the line of fracture. On opening the skull, a fissure was found traversing the right petrous bone, and extending forwards from the occipito-mastoid suture, which was separated. A minute blood-clot, a few lines in extent, lay near the fracture, within the arachnoid sac, but otherwise the membranes and brain appeared singularly healthy. Hilton reports similar cases in his admirable Lectures on the Cranium.

As long as such patients remain quiet, as long as no physiological vibrations are excited by efforts at locomotion, just so long does the brain-substance contiguous to the lines of fracture remain uninjured. The primary jarring and slight brain-contusion are recovered from; and, should quiet be sufficiently long maintained, recovery ensues. Let, however, the patient, tempted by his apparent recovery, leave his bed, and immediately the normal vibrations, which must mechanically arise, are excited. Safely conducted away in health, to points where they were annihilated, the course of the vibrations is now interrupted by the fissures, and the superposed brain-substance is jarred and probably slightly lacerated. From such constantly recurring injuries, slight though they be, in the adult, encephalitis results; in the child, perhaps fatal eclampsia.

Symptoms of Basal Fracture from Indirect Force.—Except in cases of direct hurt from thrust-wound, access cannot be had to the site of injury, and in many cases, if this were possible, little could be learned by the touch unaided by sight, as the fragments of basal fractures are rarely displaced, and

¹ Marmy, Bull. de la Soc. Anat. de Paris, p. 258. 1848.

² L'Expérience, Novembre, 1843. (Hewett.)

³ Marmy, loc. cit., p. 193.

⁴ In the Wood Museum (Bellevue Hospital, New York) is an uncatalogued specimen, presented by Prof. F. S. Dennis, showing marked fissuring of the *left* petrous bone from a pistol-shot wound of the *right* ear. It forms a typical example of fracture by transmitted vibrations.

basal fissures are seldom widely separated. The only symptoms,¹ therefore, upon which we can rely, are the escape of blood, watery fluid, or brain-substance, by some one of the natural passages, and the detection of injury done to the cranial nerves as they emerge from the skull.

Blood may escape by the nose, from the ears, or from the pharynx. When coming from the nose or pharynx, portions are swallowed, which are often ejected by vomiting. I have seen blood, however, welling up into the pharynx, whence it issued by the mouth and nose, in a steady though small stream. The blood may also escape into the cellular tissue of the orbit and eyelids, into that of the mastoid region, or into that of the back of the head.

Orbital Ecchymosis.—Coming from the back of the orbit, the blood usually first shows itself beneath the ocular conjunctiva, where it may accumulate until it forms a brownish-red, much-elevated margin around the apparently deeply-sunken cornea.² According to Hewett, the ecchymosis subsequently spreads to the lids. Velpeau thought that the ecchymosis of the lower lid alone was a sign of basal fracture; but this symptom is of no special value without extensive subconjunctival and orbital effusion, although the lower lid usually becomes discolored before the upper. Upon the other hand, fracture of the anterior portion of the base may exist without ocular ecchymosis, or the lids alone may become discolored.

Marked subconjunctival hemorrhage, coexisting with orbital and palpebral effusion, is then a fairly reliable symptom of fracture of the anterior basal region, if we except those rare cases which have been reported by Holmes, where fractures of the malar or of the superior maxillary bones, produced both ocular and palpebral ecchymosis.³

But the total absence of these symptoms cannot exclude a basal fracture. Thus, of twenty-three cases of fracture of the orbital plates of the frontal bone, in eight cases there were no traces of extravasated blood, in either the eyelids or beneath the ocular conjunctiva, while in five cases the lids were alone discolored. In the ten remaining cases, blood was extravasated both beneath the ocular conjunctiva and into the lids.⁴ It will be thus seen that when these symptoms are present they are valuable aids to diagnosis, but that their absence is not conclusive in the other direction.

Injuries to the arteries at the back of the orbit have resulted in traumatic aneurisms, which often ultimately demand surgical interference.⁵

Hemorrhage from the Nose and Pharynx.—Epistaxis, from the vascular nature of the Schneiderian membrane, is a common symptom in head injuries, and can only be of any diagnostic value when persistent, and when accompanying symptoms of grave cerebral concussion. In fourteen cases out of thirty-two, where central basal fractures occurred, bleeding from the mouth or nose, or subsequent vomiting of blood, occurred. Out of the fourteen cases in which this symptom was noted, in four the ethmoid alone was involved; in three, the body of the sphenoid; and in one, the ethmoid, sphenoid, and basilar process of the occipital bone were all implicated. (Hewett.)

¹ Le Gros Clark reports a case of basal fracture, with marked cerebral laceration, in which the temperature was depressed, being 87.4° F. one and a half hours after the injury, and only reaching 90° F. nine hours subsequently. (Gant's Science and Practice of Surgery, vol. ii. p. 162.) Mr. Hulke has reported, in the *Lancet* for 1877, a series of cases in which, the patients living for some days, an excessively high temperature was developed, without any coarse post-mortem evidence of inflammation being found. In all, however, there was extensive shattering and bruising of bone.

² Maslieuret Lagemard first called attention to this subconjunctival ecchymosis.

³ *British Medical Journal*, 1855.

⁴ Hewett, *op. cit.*, vol. i. p. 589.

⁵ Morton, *Am. Journ. Med. Sc.*, vol. lx. 1870, pp. 43 and 45; Harlan, *ibid.*, p. 47.

Hemorrhage from the pharynx is often from the vessels of the mucous membrane; but in one case, mentioned by Aran, the internal jugular was torn, producing almost instant death. Pharyngeal hemorrhage, or vomiting of blood—this fluid, when retained in the stomach for any time, presenting, when ejected, the appearance of coffee-grounds—is of much less value than either orbital or aural hemorrhage. When profuse, persistent, and the result of violent, diffused force, with accompanying cerebral symptoms, it may prove useful in determining the nature of a doubtful case. Bleeding from the pharynx, or vomiting of blood, may proceed not from fracture of the vault of the pharynx or roof of the nose, but from a fracture of the petrous bone without rupture of the *membrana tympani*, so that blood entering the tympanic cavity escapes into the pharynx by the Eustachian tube. Dolbeau has pointed out a rarely-observed symptom of fractured base, viz., ecchymosis extending over the posterior pharyngeal wall from the occipital bone to the upper cervical vertebrae. It is most difficult of detection, being generally concealed by the palate.

Bleeding from the ears is the most valuable of the symptoms of fractured base, provided that it be profuse and prolonged, and that a recent rupture of the *membrana tympani* can be detected. With such conditions after a severe head injury, accompanied by cerebral symptoms, a diagnosis of basal fracture can be safely made; for copious and prolonged hemorrhage indicates a fracture traversing the petrous bone, which has opened one of the larger vascular trunks, as bleeding from those of the mucous membrane would soon spontaneously cease.¹ In one case, already mentioned, from fifty to sixty ounces escaped by the ear in the course of a few hours.²

Aran refers to two cases where post-mortem examination demonstrated a tear of the lateral sinus, and other such cases are on record. The flow of blood may continue from two to three or more days.

Hewett reports dissections of thirty-two cases of fracture involving the middle fossa, in fifteen of which there had been a free, steady hemorrhage from the ear. In these the tympanum was traversed by the fracture, and the *membrana tympani* ruptured. In twelve cases, however, the fracture did not involve the tympanum, and in the remaining five the tympanum was fractured, but the *membrana tympani* was unruptured. If, therefore, in a suspected case the *membrana tympani* be found upon examination, to be sound and non-bulging, and to present none of the appearances of blood being effused into the tympanic cavity—that is, change of color of the drumhead by the blood showing through—the fracture, if any exists, can be said not to have involved that portion of the petrous bone in which lie the internal and middle ear, and must involve the apex alone.

Where a fracture of the petrous bone opens one of the large venous sinuses and into the tympanum, as before said, hemorrhage may take place from the nose or mouth, or blood may be vomited. Indeed, this sometimes may occur even with a ruptured *membrana tympani*. The possibility of this double hemorrhage arising from a fracture of the petrous bone alone, and not from one of the bones forming the roof of the nose or pharynx, must not be forgotten in making the diagnosis, lest greater cranial injury be supposed to exist than in reality has occurred.

Filtration of blood into the cellular tissue of the *occipital region*, or into the subcutaneous tissue of the lateral parts of the *neck*, may take place in basal fracture, producing an appearance as if bruising had there occurred. If

¹ The very exceptional case mentioned by Erichsen, where a blow upon the jaw broke the external auditory meatus, and produced a free flow of blood from the ear, is so unlikely to occur again as not to invalidate the statements which I have made.

² Lockwood, *Am. Jour. Med. Sc.*, April, 1859, p. 354.

it can be proved that the portion of the head struck was far distant from the discoloration, this is a valuable diagnostic sign in conjunction with distinct cerebral symptoms, either precedent or then existing. If no reliable information can be gained as to that part of the head upon which the blow was received, ecchymosis of the regions mentioned can be of no diagnostic value, except—according to Hewett—when a puffiness occurs in the occipital region, with discoloration of the skin a few hours after a severe injury upon this part of the head. He states that this is the result of injury to some of the great venous sinuses and of filtration of the blood between the fragments. I cannot but consider this an eminently uncertain symptom when the occipital region itself has been injured.

The *escape of brain-substance*¹ by the ears or nose, of course definitely settles the fact of basal fracture, but is of rare occurrence.

The diagnostic value of *watery discharges from the ear and nose* will be considered hereafter.

Paralysis of the nerves emerging through the various foramina at the base of the skull, especially paralysis of the facial and auditory, has been from time immemorial considered a sign of fractured base. The second, eighth, and ninth pairs are but rarely affected, while the first is not uncommonly injured. Involvement of many nerves, or of those of both sides, is not of much value as evidence of basal fracture, since the symptoms are then probably due to intracranial blood-extravasation.² Paralysis of the facial often does not appear immediately after the injury; in fact, in eight out of ten cases reported by Mr. Pick, it only appeared from the second to the sixth day. Owing to the connection of the facial with the spheno-palatine ganglion, it depends on the part of the portio dura injured, whether the uvula and soft palate will be paralyzed as well as the facial muscles, or not. In the former event, the line of fracture must traverse the internal auditory meatus, so as to injure or compress the nerve before it gives off the greater petrosal nerve—that is, between the brain and the geniculate ganglion, which is situated in the first part of the aquæductus Fallopii. If the uvula and palate be unaffected, the line of fracture must traverse the petrous bone so as to injure the facial nerve as it passes in the Fallopiian canal across the internal wall of the tympanum.

Diagnosis of Basal Fractures.—The most important diagnostic points have been referred to in considering the symptomatology of basal fractures, but there are some general principles which the surgeon will do well to keep in mind when dealing with a supposed injury of this kind.

Experience has shown that, as a rule, basal fractures result from the application of powerful, diffused force. Thus, in violent blows or falls upon the temporo-parietal region, with marked symptoms of cerebral concussion, we have, according to Aran,² from the mere nature of the force, presumptive evidence of a fracture of the middle fossa. While I do not go as far as this author, such a combination of events certainly should suggest the strong possibility of a basal fracture to the surgeon's mind.

In direct fractures, free hemorrhage, or hemorrhage followed by a watery flow, with perhaps symptoms of cerebral compression from intracranial effusion of blood, is apt to occur, and paralysis of one or many of the basal nerves from injury by the vulnerating body. Then, too, an open way having been made to the site of fracture, the finger or the probe will give valuable information.

¹ Guillemeau, Journ. de Méd. 1779; De Gislain, Annales de Chirurgie, t. viii., p. 229. 1843; Aran, Archives Gén. de Méd., 4e sér., t. vi. p. 329; Lockwood, loc. cit.

² Loc. cit.

In fractures by irradiation, that is, those spreading from a fractured vault, there are always marked symptoms of cerebral concussion; usually nasal, aurial, pharyngeal, or orbital hemorrhages, according to the region injured; and, if one of the middle fossæ be broken, probably a watery discharge from the ear, either from the outset or following copious and prolonged hemorrhage. Paralysis of one or more cranial nerves—such as the first, if the anterior fossa be involved, or the seventh, if the middle fossa be broken—are also probable symptoms. All these conditions are usually complicated with decided cerebral contusion, which is followed by encephalitis, and the case not unusually terminates in hemiplegia and death by respiratory failure.

(1) *Fractures of the Anterior Fossæ.*—There is usually either a wound or a contusion of the facial or frontal region, with fracture of the frontal bone; prolonged, copious epistaxis, ecchymosis of the eyelids—especially, and first, the lower—with effusion of blood beneath the ocular conjunctiva. Either the olfactory, optic, or third pair of nerves may be paralyzed. Watery nasal discharge may occur. In very exceptional cases cerebral substance may escape by the nares.

(2) *Fractures of the Middle Fossæ.*—There is apt to be a contusion or wound of the middle zone of the cranium, usually in the temporo-parietal region; or a blow across the face or neck may be the cause of fracture. Aural hemorrhage, free and prolonged, usually takes place, followed by watery discharge, and very rarely by an escape of cerebral substance. Paralysis of the facial or auditory, or loss of the function of both of these nerves, probably occurs either primarily, or more commonly within a few days of the injury.

(3) *Fractures of the Posterior Fossæ.*—These fractures ordinarily result from falls upon the occiput, and are often complicated with fractures of the apex of the petrous bone. The symptoms are apt, therefore, to be combined with those of fracture of the middle fossæ. In occipital fractures, severe pharyngeal hemorrhage is more apt to occur than in injuries of other portions of the base, from tearing of the greater vessels which are so closely related to the roof of the pharynx.

Occasionally, as a sequence of fracture of the petrous bone laying open the tympanum, a painless, smooth, circumscribed, elastic, non-fluctuating, resonant tumor forms in the temporal or mastoid region; this is a *pneumatocele*. The air may sometimes be made to escape with a hissing sound. Pressure will cause the total or partial disappearance of the tumor, which at once reappears when the pressure is removed. Usually confined beneath the pericranium, this membrane may give way, when the air becomes more or less diffused throughout the enveloping connective tissue. Firm pressure is the only appropriate treatment, after a preliminary puncture with a fine trocar. Incision, excision of the sac, and the introduction of a seton, have been followed by serious, if not fatal, symptoms.

Prognosis.—Do basal fractures unite, and what are the chances of recovery? If the patient live long enough, union may undoubtedly occur. There is an admirable specimen of this in the Pennsylvania Hospital Museum,¹ and Mr. Henry Lee gives an account and drawing of another example in the Medical Times and Gazette for 1852. Even months or years after a fracture of the base, no attempt at union may be found, while in other cases the union may be merely by fibrous tissue, or partly a thin plate of bone, partly membrane. In some cases exuberant callus forms, consisting chiefly of porous

¹ There is also a well-marked specimen of a very extensive fracture of the vault and base, in the Wood Museum, Bellevue Hospital, New York. Decided union has taken place, the patient dying long after the injury, from some other affection.

bone, and when the line of fracture has traversed a sinus, this callus may be so excessive as to block up the channel. I have myself seen cases where there was no good reason to doubt that patients had recovered from basal fractures, yet such a result is rare. As I have endeavored to point out, and as Aran has positively stated, since basal fractures are simple linear fissures, with neither displacement nor depression, they, in themselves, add little, if anything, to the danger of the head-injury, if the brain have escaped primary harm. If perfect quiet be not maintained, as in the case of Dr. Wirgman's patient, or as in Mr. Hilton's cases, meningeal irritation and encephalitis will result, but these can often be avoided by rest and appropriate treatment. As an instance of the danger of movement, I may refer to a case of Sir Charles Bell's, in which sudden displacement of a fragment of the occipital bone at the foramen magnum, caused instant death by compression of the spinal cord. And as most basal fractures are complicated with serious intracranial injuries, it has been estimated that 80 per cent. of fatal skull-fractures belong to this variety. Even when apparent recovery has taken place, death often results many months afterwards, from secondary brain-disease.

Treatment.—As these fractures are almost never amenable to operative treatment—and as they depend for their gravity upon the concomitant intracranial injuries—even when their diagnosis is clearly made out, nothing beyond treatment appropriate for expected or present encephalitis should in most instances be resorted to. In some rare cases of injury to the more accessible portions of the base, such as the roof of the orbit or the occipital bone, operative interference has been successfully employed. Occasionally the fragments are depressed, and when this is the case, and they are accessible, they should be elevated. Thus, Hewett has seen a fragment, composing the greater part of the orbit, removed. The trephine has been successfully applied close to the foramen magnum, for a depressed fracture of that region, in a boy aged fourteen years. In this case an incision over an occipital contusion revealed a fissure which, when followed down, led to finding a depressed fragment of bone so firmly impacted as to require the trephine for its removal. Puncture of the membranes was secondarily resorted to for a serous effusion, and recovery took place.¹

WATERY DISCHARGES FROM THE SKULL.—A discharge of thin, limpid, watery fluid from the ears, nose, or other portions of the skull, is a not unfrequent accompaniment of severe head-injuries, especially of basal fractures. The source of these discharges has been so much discussed, and their importance in the diagnosis of head-injuries has been so variously estimated, that I shall here consider the subject in some detail. Observed as early as 1727,² it was reserved for Laugier, in 1839, to demonstrate by dissection that many cases of watery discharge from the ear coexisted with a fracture of the petrous bone and rupture of the membrana tympani. Opinions as to the source of the discharge may be divided, as pointed out by Hewett, into two classes: according to one, the fluid is thought to be nothing but the serum of the blood; according to the other, it is a secretion from some membrane. Laugier first broached the view that the fluid was merely blood-serum from a clot lying in direct contact with the fracture. Afterwards, he taught that the "lacerated vessels lying along the broken bone," with those of the neighboring soft parts, "contributed to the discharge by serous exudation."³ Chassaignac

¹ Med.-Chirurg. Trans., vol. ii. p. 105.

² Vander Wiel (Hewett, op. cit., vol. i. page 592).

³ Archives Générales de Médecine, 4e sér., t. viii. p. 413. Laugier (ibid., p. 386,) declares that he had carefully noted the occurrence of watery aural discharge as far back as 1835.

maintained the untenable view, that, both from the ear and nose, these watery discharges resulted from a filtration of the serum of the blood through the frayed walls of some of the venous sinuses in relation with the fractured bone.

The membrane of the internal ear, by an increased secretion of the liquor Cotunnii,¹ has been also considered as the source of the discharge, as well as the arachnoid cavity and the subarachnoid spaces.

Examining these views in detail, I would say, in the first place, that the analysis by Chatin² proves that the fluid contains only a trace of albumen, and a large quantity of sodium chloride, a fact which I have myself observed. This explodes the blood-serum theory.

When the lines of fracture of the petrous bone do not involve the internal auditory meatus, but the fissure traverses the middle and internal ear, rupturing the membrana tympani and the membranous labyrinth, we certainly cannot affirm that some of the fluid is not liquor Cotunnii, though its large quantity would tend to negative that view.³ Besides, more than one specimen has been dissected by competent anatomists, where neither fracture existed nor any abnormal communication between the two cavities, and where yet a free aqueous flow took place from the ear. Thus, as one instance:—

A man fell about twenty feet, and striking his head produced a scalp wound, not denuding the bone, at the upper back part of the head. Upon admission to St. George's Hospital there was a discharge of bloody fluid from the ear, which the next morning was roseate, gradually became clear, and was so profuse that two ounces were collected in an hour's time. On the third day it decreased and became purulent. It had been very profuse, soaking the pillow-case so as to require towels to be placed beneath the head. The patient dying upon the seventh day, Sir P. Hewett⁴ and Mr. H. Gray repeatedly examined the specimen, but detected neither fracture nor abnormal communication between the middle and internal ear; but the membrane lining the tympanum and mastoid cells was "intensely vascular and covered with muco-purulent secretion, while the membrana tympani was freely ruptured at its anterior inferior part." "The membrane lining the cavities of the internal ear was natural in every respect."

That certain of these free watery discharges really proceed from the subarachnoid spaces—that is, consist of cerebro-spinal fluid—is incontestably proved, by both analysis, dissection, and experiments upon the living patient⁵ and upon the cadaver. M. Robert was the first, as far as I am aware, to thoroughly investigate the subject and place it on a firm basis.

To allow the escape of cerebro-spinal fluid through the ear, the fracture must traverse the internal auditory meatus, open into the tympanum, and at the same time tear through the meningeal sheath⁶ which incloses the seventh nerve in the auditory meatus, and also rupture the membrana tympani. There is at least one specimen, dissected by Hewett, which proves that the tubular sheath of the arachnoid surrounding the nerves may be torn, coin-

¹ Marjolin, *Dict. de Méd.*, 2e édit., tome xxix. p. 570.

² *Ibid.* Claude Bernard has also shown that both the cerebro-spinal fluid and that poured out in basal fractures often contain a trace of sugar. So little albumen is present that it may not fairly coagulate with heat or nitric acid, but only some cloudiness or opacity be thus produced.

³ Robert (*Archives Générales de Médecine*, 4e sér., tome ix.) relates a case where 1000 grammes of fluid were lost by the ear in sixty-six hours.

⁴ *Op. cit.*, vol. i. p. 593.

⁵ Congestion of the intracranial circulation, effected by pressing upon the jugular veins and closing the mouth and nose with the hand so as to prevent respiration, in the case of a boy with fractured base, produced a marked increase in the flow of watery fluid from the ear (Hilton).

⁶ Robert (*loc. cit.*) says that even a tear of the dura mater lining the internal auditory meatus, at the point where the arachnoid is reflected upon the nerves, will allow the exudation of cerebro-spinal fluid.

cidently with a line of fracture pursuing the course which I have just described.¹

We thus see that free watery discharge from the ear may coincide with such a fracture as I have described, when it is certainly cerebro-spinal fluid; and that an equally free flow may take place with neither fracture nor injury to the internal ear. Of what value then in diagnosis are these watery ear discharges? Although cases do occur where free watery discharge takes place with neither basal fracture nor injury to the internal ear, yet this symptom is unquestionably of great diagnostic value under certain circumstances.

When the flow is copious from the very outset, having commenced immediately after the accident, and not having been preceded by any hemorrhage from the ear, or by hemorrhage in only very small amount, there is no doubt that it is an outpouring of cerebro-spinal fluid, escaping through a fracture of the petrous bone, traversing the internal auditory meatus, and tearing the infundibular process of the meninges.

Free and prolonged hemorrhage from the ear, succeeded by a watery discharge, is indicative of fracture of the petrous bone; but it does not necessarily follow that the fissure has traversed the internal auditory meatus. And it must be remembered, that, as Sir Prescott Hewett has well said, "it is not to the watery discharge that we can trust for our diagnosis, but to the copious and prolonged bleeding."²

When, however, there is at first only a moderate flow of blood, which persists for a short time and is followed by a watery discharge, variable as to time of appearance and amount, the value of the symptom is questionable. The watery flow may appear within a few hours of the injury, and may then rapidly become profuse. As the flow of blood is not enough in itself to be diagnostic, and as some of the facts which I have mentioned go to show that a profuse watery flow may proceed from the ear within a few hours of a head injury without any fracture, we are not warranted in cases of this third class in diagnosing basal fracture merely from the aqueous flow.

The statement that free watery discharges after head-injuries belong to childhood and youth, is unquestionably an error.

Prognosis.—Although often considered to be a fatal symptom, a number of recoveries have been reported; and I have had one case under my own care, of undoubted basal fracture with watery discharge from the ear, where recovery took place. Nevertheless it is a very grave symptom.

Watery discharges from the nose sometimes occur after head-injuries, but rarely as compared to similar flows from the ear.

Blandin first reported a case of this kind in the year 1840, but the source of the flux was not satisfactorily made out. An examination of a case which occurred five years later in the practice of M. Robert, revealed a tear of the dura mater about one inch in length over a fracture of the sella turcica. The visceral arachnoid covering the anterior lobes was also torn. As a proof of the source of the discharge, water dropt into the sella turcica soon filtered through into the nasal cavity, chiefly emerging through the right nostril.³ Analysis of the fluid composing these nasal discharges proves it to be identical in composition with the cerebro-spinal fluid, and a moment's reflection will show how readily large quantities of this might be poured

¹ Robert (loc. cit.) records a second case of careful dissection of a fracture of the petrous bone—watery fluid having been discharged by the ear during life—where a tear of the infundibular process of the arachnoid at the bottom of the internal auditory meatus was detected.

² Erichsen reports a fracture of the external auditory meatus from a blow on the condyle of the jaw, where many ounces of blood flowed from the ear. This is however very unusual.

³ Loc. cit., p. 417. M. L. Brown reports in the Boston Med. and Surg. Journal, Dec. 29, 1881, p. 610, an example of watery nasal discharge in a case where, after death, a fracture implicating the cribriform plate of the ethmoid bone was detected.

out from the great sub-arachnoid spaces upon which rest large portions of the base of the brain. Hewett points out that, in addition to this source, another exists in the intra-ventricular fluid, free vent to which would be afforded by a tear of the infundibulum, that is, a part of the floor of the third ventricle. The pituitary gland connected with the infundibulum lies in the sella turcica,¹ which frequently gives way in basal fractures.

Strange as at first sight the statement may appear, watery nasal discharges sometimes accompany fractures of the petrous bone, the fluid escaping by the Eustachian tube into the nose from the tympanum, to which the cerebro-spinal fluid has gained access by a fracture implicating the internal auditory meatus.

But what is the diagnostic value of this symptom as indicative of a fractured base? Very little, I think, unless it occur immediately after the injury. Even then there is no certainty about it. If with the small extent of mucous surface of the tympanum and mastoid cells, fluid may be secreted at the rate of two ounces in an hour without any fracture, surely the same is much more likely to occur from the nose. Accordingly, we find that certain individuals are liable to periodical attacks of free discharge of a limpid fluid from the nostrils, which may last for hours.² This fact must be borne in mind, lest a clear watery flow from the nose after a head-injury be considered of too great diagnostic value.

In certain cases of compound fracture of the *vault*, where the membranes have been lacerated, a free discharge of the cerebro-spinal fluid takes place.³ Although in most instances the fluid comes from the sub-arachnoid space, this is not always so. In three cases, one of which has been already quoted in this article,⁴ the fluid came from the lateral ventricles. In these cases the flow was very free, and in two of them it came on suddenly at a late period.⁵ All proved fatal.

Prognosis of Cases complicated by occurrence of Watery Discharges.—What is the prognostic import of these losses of cerebro-spinal fluid? In themselves, they seem to exert no appreciable effect upon the course of the case, but as they prove an opening into the sub-arachnoid space or into the ventricles, they indicate the existence of visceral lesions which always add to the dangers of any skull-fracture. Where the ventricle is not opened, recovery seems to be the rule. Thus out of eleven cases cited by Hewett, eight ended in recovery, the three fatal cases being those in which the lateral ventricle was laid open.

Treatment.—This must consist in the adoption of appropriate measures, as indicated by the general symptoms. In other words, the case must be treated upon an expectant plan, with no special reference to the escape of fluid.

TRAUMATIC CEPHALHYDROCELE.—Prof. P. S. Conner,⁶ of Cincinnati, has collected 19 cases of this rare affection, the list including two reported by himself.

A traumatic cephalhydrocele consists in a subfascial accumulation of fluid, in most instances the result of a simple fracture of the cranial vault. In two cases of gunshot injury, where there had been a communicating wound

¹ In Blandin's case, before mentioned, this accident probably occurred. (Reported by Demarquay, *Gaz. des Hôpitaux*, p. 205. 1840.)

² See Hewett, *op. cit.*, vol. i. p. 596.

³ Dudley, after trephining for epilepsy, found a bony spicule which pressed on the dura mater; the next day fluid commenced to flow and continued to do so for eight days, recovery ensuing. (*Am. Jour. Med. Sciences*, 1828.) O'Halloran (*Dub. Med. Press*, vol. xiii. p. 81), and Hey, of Leeds (*Practical Observations in Surgery*, p. 21), also report instances of watery flow from the vault after fracture.

⁴ Bouchacourt, *Bull. de la Soc. Anat. de Paris*, tome xiii. p. 13.

⁵ Erichsen, *op. cit.*; also Hewett, *op. cit.*, vol. i. p. 597.

⁶ Proceedings of American Surgical Association, 1884.

of the scalp which had closed, and in one case of compound fracture where the external trephine-wound had cicatrized, a similar collection of fluid subsequently occurred. These cases are additional to the 19 already mentioned. There can be no question as to the nature of the fluid, which is most clearly cerebro-spinal; and in three cases a communication with the lateral ventricle has been detected.¹ Where the original injury is not compound, traumatic cephalhydrocele occurs only in the young, 18 cases having been in patients under three years of age, while in one case only (Conner) was the patient 12½ years old. This is explicable, according to Dr. Conner, in part at least, by the yielding character of the skull-bones in the very young, admitting of great depression and fissuring of the vault, without associated wound of the scalp.

Symptoms.—Traumatic cephalhydrocele may appear at once after the injury, or not until the expiration of four months, and a positive diagnosis is often impossible without a withdrawal and examination of the contents of the swelling. A typical case presents a soft, compressible tumor, covered by normally colored, distended integuments, so thin, perhaps, as to be translucent. In more than one-half of the cases, pulsation was apparently not observed.

When this symptom is present, with those already described; when pressure diminishes the bulk, with or without evidences of cerebral irritation; when the tension of the swelling is increased by crying or holding the breath; and when the condition noted has followed a simple fracture of the vault, the *diagnosis* is clear. When, however, there is neither pulsation, translucency, nor evidence of fracture, if appearing early, the condition will probably be mistaken for a hæmatoma, or, when coming on long after the injury, for a deep-seated abscess. Under such circumstances an examination of the fluid can alone determine the nature of the swelling, and an exploratory aspiration is therefore indicated in doubtful cases.

Prognosis.—The mortality of traumatic cephalhydrocele depending upon simple fracture, Dr. Conner shows to have been 50 per cent., death in fatal cases having resulted from encephalitis; while when the disease has followed compound fracture, one-third of the patients have died, from cerebral abscess. Recovery, when it does ensue, is followed, in many cases, by a morbid mental state, irritability of temper, etc. Though complete consolidation of the fracture, with consequent abolition of the communication between the intracranial and extracranial cavities, may occur, it is, according to Dr. Conner, very unlikely to take place in any case in which the opening has been large and the subaponeurotic accumulation great.

Treatment.—Nothing beyond aspiration or tapping with a fine trocar is admissible, and this only when symptoms of intracranial pressure, such as squinting, pain, or “decided symptoms of distension of the nasal or orbital lymph spaces,” are noted. The sac should not be completely emptied, lest cerebral irritation result, as actually occurred in one of Dr. Conner’s cases, when pain in the forehead and side of the head compelled him to discontinue the operation. Moderate—but only moderate—pressure may, perhaps, lessen the rapidity and extent of the distension. The following conclusions are drawn by Dr. Conner, as the result of his researches and experience.

1. Simple fracture of the vault of the skull may give rise to a collection under the scalp of the cerebro-spinal fluid; coming, it may be, only from an opened ventricular cavity.
2. Such traumatic cephalhydrocele may be developed quickly, or only after the lapse of a number of days or even weeks.

¹ Guy’s Hosp. Reports, 3d series, vol. xxv. p. 91. Archiv f. klin. Chir., Bd. iii. S. 398; Jahrbuch f. Kinderheilkunde, Bd. xviii. S. 367. (Conner.)

3. The condition is one that has thus far been noticed only in young subjects.
4. The accident is quite likely to prove fatal from lepto-meningitis or meningo-encephalitis.
5. Operative interference should be restricted to the removal by aspiration of a limited amount of fluid; and such aspiration should be made only when severe pressure-symptoms have manifested themselves.
6. A similar fluid accumulation may occur after closure of the external wound of a compound vault-fracture or of a trephining.

SEPARATION OF SUTURES.—When occurring in the cranial vault, these accidents are, as a rule, restricted to the young, in whom the skull-bones have not as yet become co-ossified.¹ In later life, force applied at the site of an obliterated suture may cause a fracture which accurately follows the old sutural line, as in a case recorded by Prof. Agnew.² In the Wood Museum, New York, is a specimen (uncatalogued) where the line of fracture has passed exactly through the obliterated interfrontal suture. The injury resulted from diffused force, that is, a blow from a sand-bag. A musket-ball may, according to Guthrie, produce separation of a suture of the cranial vault, by impinging directly upon it with a moderate degree of force, although “in general it takes place when the ball happens to lodge, as it were, between the bones concerned in the formation of the suture.” Guthrie³ reports one case where separation of the sagittal suture was caused by a fall upon the vertex, the patient dropping from his saddle with a bullet-wound of the thorax. In basal fractures of the skull, the sutures of other parts are not uncommonly separated. In fourteen cases of fracture accompanied by separation of sutures, examined by Hewett, the coronal suture was separated in seven cases, the lambdoid in six, the sagittal in four, the petro-occipital in one, the temporo-parietal in one, and the sphenoparietal in one. Referring to the great rarity of such accidents, he remarks that he has never seen but one example uncomplicated with fracture. In this case the temporal bone was slightly separated and driven upwards at the back part of the squamoso-temporal suture, closely simulating a fracture with depression.⁴ I have lately seen a case where the squamosoparietal suture was slightly separated by a blow upon the parietal, which must have been slightly depressed, as the squamous plate was at one point about a line above the parietal bone. The sagittal (twelve times) and the masto-occipital suture (seven times) have been those most commonly separated in the twenty-one specimens of fracture with sutural separation which I have examined. Where a number of sutures have been loosened, a whole bone, as for instance the frontal, may become almost detached from those around it.

Prognosis.—Separation of sutures is most frequently effected by the application of great force, such as firm compression of the head between two hard, resisting bodies, falls from a great height, or the impact of a spent cannon ball. In consequence, the prognosis is very bad,⁵ for the bone-injury is frequently complicated by extensive pericranial laceration, or by separation of the dura mater, while at times both these membranes are freely torn, with laceration and extrusion of the brain-substance, which, under such circumstances, may be found just beneath the integuments. This, however, is not always the case: in an extensive cranial fracture reported by Hewett, the parietals were widely separated, and at a different level along the whole extent of the

¹ Morgagni, however, reports a case in a man sixty years old.

² Principles and Practice of Surgery, vol. i. p. 274.

³ Commentaries on the Surgery of War, 6th ed., p. 349.

⁴ Hewett, op. cit., vol. i. p. 591.

⁵ Larrey (op. cit., p. 317) reports a case of recovery after separation of the coronal suture, death taking place from independent disease, six months afterwards.

sagittal suture, the depression of the right bone being fully two lines below the cranial surface; yet the brain itself was totally uninjured.¹ Separation of the sagittal suture has, in several recorded instances, resulted in extensive intracranial extravasation of blood, requiring the use of the trephine upon one or both sides of the median line. In one instance this condition was indicated by the presence of coma, with "a longitudinal elevation extending the whole length of the sagittal suture;"² when incised, this gave vent to liquid blood and revealed a sutural separation. Subsequently the trephine was applied upon either side of the median line, evacuating much blood, and resulting in the cure of the patient.

Treatment.—This is essentially that of fracture of the skull, except when the injury causes intracranial hemorrhage, when the treatment is that which has just been indicated in relating M. Mouton's case.

All compound fractures of the skull, whether operated upon or not, should be thoroughly irrigated with the corrosive sublimate, carbolic acid, or some other antiseptic solution, and then carefully dressed with sublimate gauze, a full Listerian dressing, or, in default of these, with any other antiseptic dressing that the circumstances may admit of.

INJURIES OF THE MENINGES AND BRAIN.

INTRACRANIAL EXTRAVASATIONS OF BLOOD.—Blood may be effused (1) between the dura mater and the skull; (2) in the cavity of the arachnoid; (3) on the surface of the brain—that is, in the meshes of the pia mater; (4) in the cerebral substance; and (5) in the ventricles of the brain. Although these collections may occur without fracture, they are much more commonly concomitants of such an injury.

(1) *Extravasation between the Dura Mater and the Skull.*—The sources of the hemorrhage are threefold, viz: (1) the small vessels passing from the menbrane to the bone; (2) the middle meningeal artery; and (3) the venous sinuses of the brain. Extravasations from the first source are usually very limited, and have been mentioned in connection with bone contusion; the effusions which come from ruptures of the meningeal artery or its branches are by far the most common, for "out of thirty-one cases of fracture of the skull, accompanied by extravasation," . . . the hemorrhage proceeded "from the middle meningeal artery in twenty-seven cases."³ Extravasation due to rupture of one of the sinuses is the least common variety, but when it does occur may be very extensive, as in a case reported by Hewett, in which the lateral sinus was torn, "just as it turns under the petrous portion of the temporal bone."⁴

The anterior branch of the middle meningeal artery is usually said to have been ruptured at the anterior inferior angle of the parietal bone. A moment's consideration of the course pursued by the artery, after its entrance through the foramen spinosum, will show that in the most common variety of basal fracture of the skull, viz., that which involves the middle fossa, the vessel may be torn at any point from its entrance into the skull up to the anterior inferior parietal angle. The artery, in addition, frequently divides into two branches of nearly equal size, soon after its entrance into the skull.

¹ Hewett, op. cit., vol. i. p. 592.

² Monton (Quesnay, *Memoirs of the Royal Academy of Surgery*, translated by Ottley, p. 8).

³ Holmes's *System of Surgery*, 3d ed., vol. i. p. 575.

⁴ It has been demonstrated by experiment, that a clot between the dura mater and bone, equalling one-twelfth the capacity of the cranium, will produce coma and death within a few hours.

The anterior division proceeds to the anterior inferior angle of the parietal bone,¹ while the other branch, passing much more posteriorly, ramifies over the whole of the parietal, and also sends branches to the contiguous portions of the frontal and occipital bones. From these anatomical considerations, it will be seen that extensive extravasations of blood may arise from rupture of the middle meningeal artery, from lines of fracture which do not involve the anterior inferior angle of the parietal, but which run across some of the large branches just mentioned. From whatever source proceeding, the hemorrhage is large in amount from the extensive, coexistent separation of the dura mater.² The clot forms a "hard, granular mass, breaking down with great difficulty, even under heavy pressure, and adhering most firmly to the parts between which it is lying."³ The subjacent brain itself, in a large extravasation, is depressed in a cup-like manner, and the convolutions of the brain are apparently flattened. The statement that hemorrhage from laceration of the great meningeal artery may cease from compression by the resultant clot, after a small effusion of blood, is probably purely theoretical.³ If the patient survives, the clot becomes decolorized and absorbed, to judge from the appearances presented by one case reported.⁴ Punctured wounds, as from a penknife blade or fragment of glass, have been reported, where death resulted from extensive effusion due to a division of one of the large meningeal branches.⁵

Symptoms.—These are very variable, being dependent upon the greater or less rapidity of the sanguineous effusion, and are, in brief, those of compression. With marked collapse and consequent feeble circulation—perhaps from the small size of the effusion—the ordinary phenomena may be delayed for hours, even days. The symptoms differ from those consequent upon depression of bone, or the pressure of a foreign body, in not being immediate. Thus, after a blow upon the head, the ordinary phenomena of concussion are observed. With the feeble circulation the effusion is very slight, but, as reaction takes place, the blood rapidly collects between the dura mater and the bone. The patient usually regains complete consciousness, but the symptoms of concussion may, in some instances, become so merged with those of compression, that a differential diagnosis between compression from depressed bone, subcranial hemorrhage, and contusion of the brain, is impossible. (In such cases, the elevation of depressed fragments often gives vent to extravasated blood, which is then seen to have been the cause of the symptoms of compression, rather than the displaced bone.) Soon, generally within half an hour—although, when the flow is gradual, the brain accommodates itself to the pressure, so that many

Fig. 1088.



Punctured fracture of skull by a piece of glass, with wound of middle meningeal artery. (From a specimen belonging to Prof. Conner, of Cincinnati.)

¹ The groove in which the vessel lies is often converted into a bony canal, thus rendering rupture of the artery almost certain when this portion of the bone is broken.

² Although the primary separation effected by the blood is the chief factor in this condition, yet a collection of fluid blood, once formed between the dura mater and the bone, and communicating with an open artery, must, upon well-known hydrostatic principles, tend to extend, and to dissect off the membrane still further until clotting occurs.

³ S. W. Gross reports two cases, in private practice, with large clots, where the blood flowed freely from the trephine holes, despite the clots.

⁴ Hewett, *op. cit.*

⁵ Conner, Cincinnati Lancet and Clinic, Jan. 5, 1884.

hours or days may elapse—the patient becomes unconscious; the respiration, at first laborious, usually becomes stertorous, while, at times, there is a peculiar whiff at the corners of the mouth; the pupils are either contracted or dilated—generally the latter—or one is dilated and the other contracted, but in any event insensible, or nearly so, to light; the pulse is full and slow; and there is paralysis, more or less complete, of the side opposite to the effusion, with diminution of its temperature. In addition, there may be retention of urine and involuntary discharge of feces. An epileptiform convulsion, after the interval of consciousness, may usher in the symptoms of compression. Prof. S. W. Gross reports the following instructive case:—

A young soldier was struck senseless by a piece of shell, but soon recovered, vomited, and, although obliged to rest frequently, walked to the rear, a distance of nearly three miles. He appeared drowsy and unwilling to move, after each stoppage. He was perfectly rational, was restless during the early part of the night, moaning so as to disturb his companion, but at the latter's request keeping quiet, and in the morning seemed in a profound sleep. His comrade failing to rouse him, Dr. Gross was called, and found him in a state of profound coma, with a slow, stertorous, puffing respiration. The pulse was eighty-four, small and feeble; the "pupils dilated—the left nearly to its utmost extent—and completely insensible to light." Slight left hemiplegia was noted, with contraction of the flexors of both arms. "The left leg was firmly extended, powerless, and not so sensible to external impressions as the right, which was in the same condition, but to a less degree." There was a lacerated scalp-wound, just below the right parietal eminence, without fracture. Death ensued after five hours, and, upon opening the skull, an enormous clot was found between the left parietal bone and the dura mater, completely filling the middle fossa of the skull, and thus compressing the left third nerve at the sphenoidal fissure. A linear fracture passed through the left speno-parietal suture, dividing the bony canal inclosing the middle meningeal artery, which was torn. Corresponding to the site of the contused but unbroken bone, the brain was ecchymotic, and contained a small clot, "the size of a hazel-nut."¹

This case teaches two important lessons, viz., that the effusion of blood may take place upon the side opposite² to that of injury; and that rupture of the meningeal artery is apt to be complicated with contusion of the brain.³ An explanation is also afforded of the condition of the pupils. When the third nerve upon one side only is compressed, the pupil of that side will be dilated, while if the nerves of both sides are pressed upon, both pupils will be dilated. It is probable that where one pupil is dilated and the other really contracted—not merely in its normal condition—the nerve upon the side of dilatation is so compressed as to have its function abolished, while upon the side of contraction the effusion has simply irritated the nerve and exalted its function. I dwell upon these minuter points because of the marked obscurity in the diagnosis of the injuries now under consideration. If the corpora quadrigemina be either compressed or much lacerated, dilatation of the pupil occurs; a fact which must not be lost sight of, lest a severe contusion or laceration of the brain be overlooked. In exceptional cases there may be no loss of consciousness, and this condition may persist until shortly before death. The hemiplegia may also be imperfect, or may even be transient, with so large an effusion as three ounces poured out in the sphenoidal fossa.⁴ With large effusions there may be no stertor; the pupils may be normal or nearly so; the pulse may be soft, compressible, frequent, or irregular; and paralysis may be absent or incomplete.

¹ Loc. cit., p. 45.

² Erichsen reports a similar case. (Op. cit., vol. i. p. 555.)

³ In twenty-five cases of large extravasations of blood between the bone and dura mater, observed at St. George's Hospital, the brain was more or less extensively lacerated in every one. Hewett, op. cit., vol. i. p. 576.

⁴ Hutchinson, London Hospital Reports, vol. iv. p. 44.

Diagnosis.—It is important to note, first, that Duret has shown that, owing to the dura mater being freely supplied with sensory nerves mainly springing from the fifth pair, certain symptoms are occasionally present when this membrane is irritated, which are also those of lesions of the brain-substance. As a guide in the differential diagnosis, I would, after Stimson and Duret, give the following points:—

A slight injury of the brain-cortex will probably evidence itself, primarily, by exaggerated functional activity of the part, viz., muscular twitching, while from a destructive lesion, paralysis will result, and in both cases the abnormal symptoms will be on the side opposite to that of injury. Lesions of the dura mater are more apt to produce spasms and contractures of the voluntary muscles on the side of injury; “they tend to become more or less generalized, and involve the neighboring muscular groups; and never have the localization and voluntary appearance of contractions induced by lesions of the cortex;” finally, paralysis never occurs.

From the frequent coexistence of contusion and laceration of the brain,¹ which, as we shall see, present symptoms closely simulating those of large subcranial effusions, a positive diagnosis is often impossible, especially in the exceptional cases just described. When, however, a patient receives a blow upon the head which stuns him, recovers consciousness for a variable but distinct interval, then becomes gradually comatose, and has opposite hemiplegia, with dilated pupil and diminished temperature of the paralyzed side, the diagnosis is easy. Sir Prescott Hewett relates the following typical case:—

A man came to St. George's Hospital a few minutes after having been struck with a spade just over the anterior inferior angle of the parietal. A compound fracture with depression of a small piece of the skull was detected, with an entire absence of cerebral symptoms. In a short time, however, “the patient became heavy and stupid, and coma was gradually supervening, when Mr. Keate arrived and at once proceeded to remove the depressed bone; whereupon a jet of blood spirted from a large branch of the middle meningeal artery, all the symptoms of compression were immediately relieved, and the patient recovered.”²

In every case of this kind, however obscure, if a distinct history of an interval of immunity from cerebral symptoms is obtained after a head injury, the presumption is that at least subcranial hemorrhage is present. If with this, one pupil is dilated, and we have a bruise, or even the history of a blow upon that side of the skull, the presumption almost amounts to a certainty. If now there are symptoms indicating involvement of the whole or a part of the motor area of the side of injury, with dilated pupil,³ we are warranted in affirming that there is an intracranial effusion of blood whose site we can define with reasonable accuracy, provided that there is an entire absence of the symptoms of brain contusion, such as tonic spasm of the muscles, extreme restlessness, etc.⁴ The symptoms of concussion are immediate and transient, and therefore cannot be confounded with those of effusion of blood. Compression symptoms after a depressed fracture will be immediate, if due to the displaced bone; if of later development, they are probably due to effused blood. When the compression symptoms come on very soon after the injury, there is either extensive detachment of the dura mater, or some of the large meningeal branches have given way, or both conditions coexist. When a menin-

¹ Erichsen (op. cit., vol. i. p. 555) reports two cases where ruptures of the meningeal artery resulted from most trivial injuries.

² Hewett, op. cit., vol. i. p. 576.

³ See section on cerebral localization.

⁴ I am aware that many cases of brain contusion fail to give any such immediate or remote symptoms, but certainly when these symptoms are present, post-mortem examination will reveal contusion of the brain. When such symptoms are present, the accuracy of any diagnosis of intracranial extravasation of blood is more than questionable.

geal branch is the source of the effusion, the clot is likely to be located at the side and base of the brain. Unless the shock and collapse are exceptionally prolonged, when the force of the circulation will not suffice to dislodge the clots in the torn vessels and overcome the resistance of the inverted vascular tunics, the delay of hours or days in the appearance of compression symptoms indicates a limited separation of the dura mater, and shows that the source of the hemorrhage is rather from the dural vessels than from the meningeal artery. Alcoholism may be differentiated by the thermometer, the temperature being markedly subnormal,¹ and by the flushed, turgid face, instead of the pallor which attends severe injury. Drunken men with head injuries should be carefully watched until sufficient time has elapsed for recovery from intoxication, as there may be concomitant cerebral injury which otherwise might escape detection. Apoplexy, causing a fall, with a consequent scalp wound or cranial fracture, is a condition which would be impossible of recognition without the testimony of some eye-witness as to the fall having been produced by some precedent head trouble. In opium poisoning, the pupils are both contracted to the size of a pin-point instead of being widely dilated, or one being dilated and the other only moderately contracted.

Treatment.—To be of any avail, this must effect the removal of the blood already effused, and the prevention of further hemorrhage. The aid of the facts of cerebral localization must be invoked, together with a knowledge of the anatomical course of the two main divisions of the great meningeal artery. If the symptoms rapidly supervene, an opening at either the anterior inferior or the posterior inferior angle of the parietal bone, will probably reveal the source of hemorrhage, unless cerebral topography indicates some other point for the application of the trephine. When found, the injured vessel may be secured by plugging its bony canal with the point of a sharpened match, with a pellet of wax, or with a red-hot knitting needle. Early operation is indicated, since it affords the best prospect of success, as shown by results. Thus out of forty cases which I have collected in which operations have been performed under these circumstances, twenty-four have ended in recovery and sixteen in death.² Twenty-two were primary operations, of which number eight were fatal; two operations which were successful, were probably early, but I cannot ascertain the details; while of sixteen secondary cases, only one-half recovered. Several of the successful cases occurred within the past twenty years, thus refuting Mr. Hutchinson's statement that no modern instances of success are on record. The cause of death is usually suppurative encephalitis. If the dura mater does not rise up to the cranial level, the prognosis is bad, the dural depression probably indicating extensive injury of the subjacent brain substance. The trephine should be of large size, and should fluid blood issue from the first opening, and the source of hemorrhage not be detectable, one or more openings should be made along the course of the meningeal artery until the bleeding point can be reached. According to a statement in Dr. Keen's edition of Mr. Holden's "Landmarks," the vessel will be uncovered by a trephine applied with its centre-pin about an inch and a half behind the external angular process of the frontal bone, and the same distance above the zygoma. A number of the cases above referred to, were instances of depressed gunshot fracture from non-penetrating projec-

¹ Agnew (op. cit., vol. i. p. 285) quotes Dr. B. W. Richardson to this effect.

² S. W. Gross, fourteen cases (Am. Journal of the Med. Sciences, New Series, vol. lxi. p. 45); Mouton, Dru, and Pineau (Quesnay, Memoirs of the Royal Academy of Surgery, Trans. by Ottley, pp. 8, 12, 14); Physick (Gross, System of Surgery, 6th ed., vol. ii. p. 55); Conner (Cincinnati Lancet and Clinic, Jan. 5, 1884); Hennen (Military Surgery, Case XLIX.); Guthrie (Commentaries on the Surgery of War, 6th ed., p. 349); Keate (Holmes's System of Surgery, 3d ed., vol. i. p. 576); Tatem (ibid.); S. D. Gross (op. cit., vol. ii. p. 55); Erichsen (op. cit., vol. i. 556); Larrey (Mil. Surg., vol. i. p. 306); Guthrie (Commentaries, pp. 315, 316), etc.

tiles; they are particularly instructive as giving the results of treatment of ruptured intracranial vessels, as nearly uncomplicated with cerebral injury as it is possible to conceive. Where an operation appears contraindicated, perfect quietude, cold to the head, purgatives, perhaps blood-letting, certainly an antiphlogistic diet, and the constitutional effect of mercury, should be tried. At a later stage of the case, iodide of potassium is indicated. I fear, however, that only a mistaken diagnosis will ever give time for such treatment, and that when cases of supposed marked extravasation between the dura mater and skull end in recovery, some other condition will have really existed.

(2) *Hemorrhage into the Cavity of the Arachnoid.*—This is the most common site for traumatic extravasations of blood, which is found in the arachnoid cavity not only in the majority of severe head injuries, but “also in cases where the injury has been a trifling one, and that without any apparent lesion either about the brain or its membranes.”¹ The sources of the hemorrhage are the vessels of the pia mater, with tearing of the visceral arachnoid; the superficial cerebral veins; and the great sinuses; and this form of extravasation may even coexist with effusion of blood from vessels between the dura mater and skull, the blood finding its way into the arachnoid cavity by a rent of the former membrane. In most instances the situation of the blood corresponds to the cerebrum, sometimes to the cerebellum, and very rarely to the medulla oblongata. Blood thus effused undergoes certain important changes, to which I would here call attention.² At first after coagulation, the blood forms a membrane-like expansion which is accurately moulded by the parts between which it lies. When in large quantity it may cap both cerebral hemispheres. In time the coloring matter of the blood more or less disappears, when the decolorized clots present the appearance of membranes of varying hues, such as are found in the arachnoid cavity after head injuries, and were formerly erroneously considered to be of inflammatory origin.

“In slight extravasations” only a mere film is found after the lapse of a few days, “so delicate and so slightly tinged as easily to escape notice.” In most cases these false membranes are firmly attached to the parietal arachnoid, present a smooth, polished, serous-like surface, and are throughout supplied with numerous vessels, which are often detectable by the naked eye. Even as early as the twenty-third day, these characteristic appearances may be well marked.

At first “soft and pulpy,” these membranes may subsequently become “leathery, fibrous, or even cartilaginous.”³ Owing to the serous-like covering that these effusions early become coated with, there is a most deceptive appearance of the hemorrhage having been between the parietal arachnoid and the dura mater, thus stripping off the former. It has been only of late years that the French pathologists have pointed out the true nature of these appearances. Doubtless the organization of these clots is effected after the manner of those found after the ligation of arteries, so ably investigated by Rindfleisch and by E. O. Shakespeare. When the effusion is large, instead of false membranes we may have true cysts formed, either single or multilocular, containing anything from the variously decolorized remains of the original clot, up to what appears to be pure serum. Recent clots may also be found,

¹ Hewett, *op. cit.*, vol. i. p. 576.

² To Sir Prescott Hewett's article On the Extravasation of Blood into the Cavity of the Arachnoid (*Med.-Chirurgical Trans.*, vol. xxviii.), and to the same author's article on Injuries of the Head, in Mr. Holmes's *System of Surgery*, I am largely indebted, and would here once for all acknowledge the fact.

³ This refers merely to their *physical*, not to their *histological* appearances.

due to rupture of the newly formed vessels of the cyst. These cysts may contract more or less perfect adhesions to both layers of the arachnoid, but usually are firmly attached to the parietal arachnoid alone. They are more rarely found either attached to the parietal layer by a few filaments, or perfectly free in the arachnoid sac. They may be of large size, as one reported by Dr. Quain, which was seven and a half inches long and one and a half inches wide at its broadest part. The cyst had formed a corresponding depression upon the upper surface of the cerebral hemisphere.¹ Not confined to any age, these cysts when large compress and flatten the subjacent convolutions, and contract the area of the corresponding ventricle. If formed in early childhood, they have been known to produce bulging outward of the cranial bones.²

Virchow has pointed out that some intra-arachnoid blood-cysts have their origin in ruptures of bloodvessels in newly-organized inflammatory false membranes.

Symptoms.—These are not characteristic when the effusion is small, and even when large it may produce no very decided evidences of compression. The signs are apt to be masked by those of cerebral laceration, a common accompaniment of intra-arachnoid extravasation. Da Costa gives the symptoms as “ordinarily pain in the head, somnolency, and profound coma with paralysis, and without anæsthesia or slow pulse, but with relaxation of the muscles, and sometimes . . . convulsions.” When circumscribed or limited to one hemisphere, the symptoms are identical with those presented by effusions between the bone and dura mater. In most cases there is an interval of consciousness after the shock has been recovered from. When this is not so, there is probably extensive laceration of the brain, and the pulse is more apt to be rapid, small, and feeble, rather than slow, full, and labored. The respirations are, according to S. W. Gross, rather labored than stertorous. Marked inequality of the pupils is rare, and the hemiplegia is not as decided as in subcranial effusion.

Diagnosis.—A differential diagnosis can, under the most favorable circumstances, be only probable, and in most instances it is impossible.

According to S. D. Gross, infants, “before the completion of the ossific process,” suffer from intra-arachnoid effusion of blood, the results of blows upon the head. The “little patient lies in a state of insensibility, and is usually affected with convulsions, or spasmodic twitches, and perhaps some degree of stertor.” The scalp is commonly severely contused, but owing to the yielding nature of the bones, no fracture exists. The fontanelle appears to be elevated somewhat above its proper level, while pressure detects increased tension, and may increase all the symptoms, especially the tendency to convulsions.

The *prognosis* is bad,³ for, even should recovery ensue, constant headache, irritability of temper, epilepsy, or insanity, may result.⁴

Treatment.—In most cases this must be that of other severe injuries of the head—the use of local cold, blood-letting, mercurials, and the iodide and bromide of potassium, as may seem indicated. In a few rare instances, where, owing to circumscription of the effusion, the symptoms resemble those of effusion between the dura mater and the bone, trephining may be resorted to, and the operation has been successful in a few such cases. After the disk of bone has been removed, the dura mater bulges into the opening, is of a bluish

¹ Trans. Path. Soc. Lond., vol. vi. p. 8.

² Lancet, vol. i. p. 416. 1846.

³ An effusion equal in bulk to one-sixth or even one-fifth of the cranial capacity seems necessary, of itself, to produce death.

⁴ Dict. de Méd. et de Chir. prat., t. xi. p. 407; Blandin, Anat. topographique, 2me éd., p. 36. 1834; Holmes's System of Surgery, 3d ed., vol. i. p. 579.

appearance, and is devoid of pulsation. The membrane should then be incised to give free vent to the effused blood.¹ In at least two reported cases, this bulging of the dura mater did not take place for hours—in one case thirty-six²—after the trephining. In the cases which occur during infancy, the elder Gross recommends leeching and cold to the head, stimulating enemata, and brisk purgatives when the child regains the power of swallowing. Failing by these means to afford relief, he advises making a crucial incision over the fontanelle, and puncturing the “distended, and perhaps purple-looking membrane,” making as small an aperture as will suffice to effect the purpose in view, after which a careful application of adhesive strips, compresses, and roller bandages must be made. In conclusion, as to operative measures, recognizing as I do the extreme difficulties presented by the diagnosis, and the small percentage of success attendant upon operative procedures in intracranial extravasations of blood, I think that three facts cannot be denied, viz., that in a certain proportion of cases life has been saved by trephining; that post-mortem records show that a number of patients have perished from intracranial extravasation of blood, who could probably have been saved by timely operation; and that trephining in such cases, though it fail to afford relief, cannot be said to measurably reduce the chance of recovery. I cannot but feel that too many cases are allowed to pass without operation, some few of which might be rescued if the surgeon were not deterred—as is too often the case—rather by considerations of what will be said if an unnecessary operation be performed, than by sound surgical contra-indications. Practically, every case which recovers after the removal of extensive intracranial blood-effusion, may be considered as one which otherwise would have died, as clinical records show that such cases almost never terminate favorably.

(3) *Hemorrhage into the Pia Mater.*—These extravasations occur much more rarely than those of the preceding variety, and are usually accompanied by some degree of cerebral laceration. Confined beneath the arachnoid, they spread far from their original source, until even the whole cerebellum and spinal marrow may thus be covered with blood proceeding from a laceration of the cerebrum only. Effusions of blood into the pia mater never become encysted, as far as I can ascertain.

Symptoms.—This condition presents no symptoms, at present known, which can be relied upon. In most cases of hemorrhage upon the surface of the brain, the patients are said to have been comatose, and to have given no evidence of partial paralysis.

Treatment.—As operative interference is out of the question, from the impossibility of removing the blood already poured out, or, even if that could be done, of preventing further effusion, such remedies as are appropriate for other severe head injuries should be resorted to.

(4) and (5) *Hemorrhage into the Brain and Ventricles.*—Large effusions into the structure of the brain may result from severe head injuries, as well as hemorrhage into the cerebral ventricles. Caution must be exercised lest cases of apoplexy from diseased vessels, either producing the fall which appears to be the cause of the head symptoms, or rendering possible a large effusion from a slight injury, should be confounded with traumatic hemorrhage in either of the situations just mentioned. Should the patient survive long enough, an unusual event from the severity of the concomitant intracranial lesions, the effused blood undergoes the well-known changes of a simple apoplectic effusion.

¹ Successful cases are reported by Morand (*Opusculs de Chir.*, tome i. p. 171. Paris, 1768), Ogle (*Brodie, Med.-Chir. Trans.*, vol. xiv. p. 391), and others. Three cases are given in Bruns's *Handbuch der praktischen Chirurgie*, Abth. i. S. 931. (Gross.)

² Agnew, *op. cit.*, vol. i. p. 286.

Symptoms.—These are essentially those of apoplexy, such as marked coma, etc., with perhaps convulsions in a few cases.

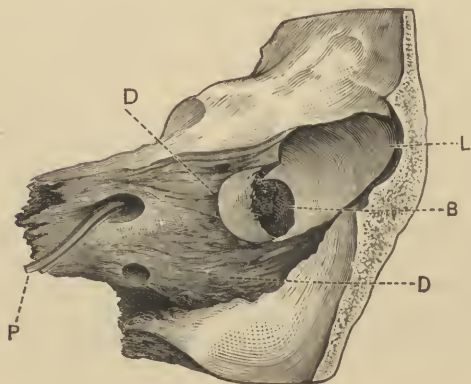
Treatment.—This, as in apoplexy, must be purely medical, and need hardly be further enlarged upon.

WOUNDS AND RUPTURES OF THE GREAT VENOUS SINUSES.—Those most commonly injured are the superior longitudinal and lateral sinuses. The mere shock of a violent blow upon the cranium may lacerate these vessels, but they are more frequently ruptured by separation of sutures. Penetration by the fragment of a depressed, comminuted fracture is the usual cause of wounds of the great sinuses, but penetrating wounds of the skull by pointed instruments or bullets may also injure these venous channels. I am led to thus specially treat of these injuries, on account of the general impression that the hemorrhage following them is usually fatal. So far is this from being true, that Pott actually bled successfully from the longitudinal sinus. Warner, Pott, and Lister, report cases where wound of this sinus was readily recovered from. In all such cases, either the application of the trephine or the elevation of fragments has given free access to the wounded vessel. Where the opposite conditions obtain, a fatal hemorrhage does at times occur. I am cognizant of one case where a prominent surgeon, while operating for a comminuted depressed fracture of the occipital bone, withdrew a pointed fragment which had been driven some distance beneath the sound skull, thus plugging a distant wound of the lateral sinus. Death resulted in a few minutes from the uncontrollable hemorrhage. I have examined the specimens from a fracture of the vertex, where the patient similarly perished upon the withdrawal of a depressed fragment. In basal fractures the hemorrhage from rupture of the sinuses may be very profuse. Thus in one case reported, it was estimated that between thirty and forty ounces were lost from the ear in the course of a few hours.

Treatment.—Where this injury is suspected in a case of compound fracture, from the propinquity of the lesion to the course of a great sinus, I would suggest that the trephine-cut, or removal of bone necessary to elevate the fragments, be so planned as to give free access to the sinus should it be found wounded. This can usually be safely done, for the injury will have probably

separated and depressed the dura mater so as to keep it clear from the teeth of the instrument. In nearly all the cases where the wound has been accessible, the application of a little dry lint, with the pressure of the finger, has at once arrested the flow. Lister filled an opening in the longitudinal sinus with a bunch of catgut ligature, and J. H. Brinton seized the lips of a wound of the lateral sinus with forceps, and tied it with fine silk. The only wound of a sinus which has occurred in my own practice, was that of the right lateral sinus, from a small pistol-ball. I suspected it from the history of a free flow of blood,

Fig. 1089.



B, opening made by ball in bony and membranous wall of lateral sinus; DD, portions of dura mater and sinus walls; L, lateral sinus with portion of its membranous wall removed; P, portio dura and portio mollis of seventh nerve.

and from the course pursued by the ball through the mastoid process. No further hemorrhage took place, the ball was supposed to have penetrated the brain deeply, and the patient died of pyæmia. Post-mortem examination revealed that the missile had just penetrated the sinus, and had plugged the opening, which finally became so enlarged by ulceration as to permit the ball to fall into the lumen of the sinus, out of which it rolled when the vessel was opened. Although not recommending such a procedure when it is avoidable, the ease with which hemorrhage from these venous channels can be arrested, proves that, as far as bleeding goes, trephining can be safely performed over the course of either the longitudinal or the lateral sinus.

CONCUSSION, CONTUSION, COMPRESSION, AND LACERATION OF THE BRAIN.—Certain preliminary anatomical facts must be considered, and a brief glance taken at the result of Duret's experiments,¹ before a clear idea can be obtained of the pathology or phenomena of concussion, cerebral contusion, and laceration. Duret's observations on injuries of the dura mater have already been adverted to.

The skull forms an exceedingly elastic case; in proof of which fact, an experiment of Félizet² need alone be adduced. He filled a skull with melted paraffine, which was allowed to cool. The skull was then dropped from the height of two and a half feet, and examined. Opposite the point of impact, the paraffine was depressed for an area of more than an inch, the centre of the depression being one-third of an inch in depth, or, in cubic measure, 0.13 of a cubic inch, which was a very considerable amount for such a moderate blow.

The cerebro-spinal fluid is, roughly speaking, divided into two parts, viz., the ventricular and peripheral, communicating with each other by the narrow foramen of Magendie at the lower end of the fourth ventricle. The major part of the ventricular fluid is collected in the lateral and third ventricles, communicating with the smaller quantity in the fourth ventricle through the contracted *iter e tertio ad quartum ventriculum*. The relative bulks of these two portions must be kept clearly in mind. The peripheral portion begins in, or is continuous with, the lymph-sheaths of the fine cerebral arterioles, a fact never to be lost sight of, as it explains disseminated contusion of the brain. The spaces between the convolutions communicate on the one hand with the minute arterial lymph-sheaths, and on the other with larger sacs, the chief of which are located at the base of the Sylvian fissure, a central one at the base of the brain, an inferior cerebellar behind and below the cerebellum, and a terminal sac at the inferior extremity of the spinal cord. The inferior "cerebellar lake"³ communicates with the fluid of the ventricles through the foramen of Magendie. The subarachnoid space in which is contained the cerebro-spinal fluid, really consists of a delicate meshwork supporting the thin-walled bloodvessels.

I. CONCUSSION OF THE BRAIN.—Concussion is the term used by Duret to indicate the symptoms of a sudden arrest, or suspension, of the cerebral functions, by force transmitted through the cerebro-spinal fluid to more or less distant portions of the brain, mainly, he thinks, to the fourth ventricle. The importance of Duret's experiments must not be pressed too far, but they certainly indicate the manner and points at which much less severe lesions may, and, as will be seen, do, occur in man. The elastic skull, yielding to the blow, compresses the cerebral hemispheres and the peripheral cerebro-spinal fluid. The

¹ Études expérimentales et cliniques sur les traumatismes cérébraux, tome i., 1878.

² Recherches anatomiques et expérimentales sur les fractures du crâne. Paris, 1873

³ This is Duret's term.

compression of the hemispheres drives the larger fluid contents through the communicating passage into the fourth ventricle, which is of small capacity, the result being, as Duret found, a rupture of the median line of its floor, and a dilatation of the Sylvian aqueduct and the central canal of the cord. This could not occur, according to hydrostatic laws, if the peripheral fluid was as free to move as the intra-ventricular. What does clinical and post-mortem experience show? That such appearances, much less marked to be sure, are occasionally seen after death, and that similar, but slighter, evanescent lesions would explain in a perfectly satisfactory manner some of the clinical symptoms of concussion. What, however, do we more commonly see in autopsies of concussion cases? Intra-arachnoidean extravasations and effusions of blood into the meshes of the pia mater, with contusions of the brain-substance. Duret shows that these are due to the waves communicated to the subarachnoid fluid, which distends the meshes supporting the bloodvessels, thus resulting in the latter's rupture. This satisfactorily explains the causation of many of these extravasations, but some of these injuries are due to direct transmission of vibrations through the cranial walls. From the wide distribution of the cerebro-spinal fluid, it is clear how force acting upon and through it, produces disseminated lesions. Recalling the fact that the small cerebral arterioles are surrounded by minute prolongations of the subarachnoid space, that is, lymph-sheaths, a ready, and indeed the only, satisfactory explanation of the disseminated form of minute cerebral extravasations is at once found. The impulse of the blow causes distension of the perivascular sheaths, whereby the arterioles are directly compressed, and the capillaries indirectly through the brain-substance; when the pressure is rapidly removed, as when the force ceases to act, "the vessels burst from the unopposed tension of their contents." An equally beautiful explanation of most of the symptoms of concussion is afforded by Duret's observations. From contraction of the arteries, resulting from spasm of their muscular coats, the venous tension at once falls,* producing an intense cerebral anæmia which causes the primary loss of consciousness. The spasmodic arterial contraction¹ is followed by a paretic dilatation which may prolong the loss of consciousness. If this be followed by a generalized inflammation, the unconsciousness may be prolonged until death.

Viewed in the light of these experiments, further explanation of the phenomena of cerebral concussion will be unnecessary, and I shall define concussion of the brain as "An assemblage of symptoms by which we recognize that a sudden arrest or suspension of the cerebral functions has taken place, the result of a commotion of the cranial contents, which may be produced, directly, by force applied to the head, or, indirectly, by an impulse transmitted through the spinal column, as by a fall from a height upon the feet, knees, or buttocks."

Many authors teach that slight cerebral concussion, as evidenced by a momentary loss of consciousness and muscular power, followed by an apparent immediate return to the normal state, is produced by "cerebral vibration without visible lesion," and is due to "a simple molecular disturbance of the

¹ Huguenin, following Fischer, teaches that concussion is due to a reflex paralysis of the intracranial vessels, the result of a powerful peripheral irritation. Anæmia of the arteries and hyperæmia of the veins, he says, are the only constant post-mortem appearances found in concussion. (See Ziemssen, *op. cit.*, vol. xii.) Duret maintains that there is an intense spasm of all the muscles in concussion, which is so transient as generally to be overlooked, but the vascular spasm, from contraction of the muscular coat of the arteries, is more persistent; obstruction is offered to the blood-current: the tension in the veins is enormously decreased; and most marked anæmia of the brain, with the primary symptoms of concussion, results. The congestion is secondary, the result of paretic or inflammatory dilatation from the irritation of the numerous hemorrhagic lesions. It will be thus seen that the latest experimenters have practically arrived at the same results.

cells." This view is the outcome of the histories of several imperfectly recorded cases, where there was no proof that the cause of death was not situated far distant from the head. These were cases of instantaneous death without perceptible lesion of the brain or its membranes; wherefore, argue the vibratory theorists, this absence of all lesion must be still more true for the cases where recovery ensues. Unfortunately for the theorists, neither the spine nor the heart was examined in the cases referred to. Littré's case is eminently suggestive of death from a broken or dislocated spine.¹ Hewett gives two illustrative cases, showing how careless post-mortem examinations tend to perpetuate false theories of disease. One or more of the conditions found in these cases probably existed in those in which instantaneous death was supposed to have resulted from pure cerebral concussion, without any post-mortem evidence of injury to the brain or its envelopes.

A man was admitted into the Hôpital St. Antoine, having fallen from a great height upon the pavement. He was collapsed and insensible, but presented neither paralysis nor muscular spasm. After some hours he died. Upon post-mortem examination of the head alone, not a trace of injury was detected in any of the cranial contents, and the case was considered one of death from cerebral concussion. Fortunately, Dr. Deville, hearing of the absence of all lesions, proceeded to lay open the spinal canal, which he found filled by an extensive extravasation of blood, extending even beyond the point where the spinal cord had been divided when removing the brain.²

Hewett also relates the case of a boy suffering from concussion of the brain, whose intracranial contents showed comparatively trivial lesions, while an examination of his chest, which outwardly bore no evidence of traumatism, showed a rupture of the muscular tissue of the septum of the cardiac ventricles, extending up to but not through the serous covering.

But what does actual post-mortem examination show to be the condition in slight cases of concussion, where death has ensued within a short time from other injuries? In two cases reported by Hewett, where "symptoms of concussion of the slightest nature had altogether passed off within a very short time," the brain-substance itself was actually injured. In the first, where there had been mere "giddiness" from a blow upon the head, followed by complete recovery, patches of contusion were found at the base of the brain, in two or three places, of the size of a shilling; these patches consisted of minute specks of blood closely grouped together, extending about a line in depth into the brain-substance. The second case was one where, after a fall upon the back of the head, the concussion-symptoms soon disappeared, and death resulted from another disease eight days subsequently. Thin layers of coagulated blood were found firmly adherent to the parietal layer of the arachnoid, while the larger veins upon the cerebral surface were congested, as well as the brain-substance itself, which was rendered much darker from this cause. In the "centrum ovale, close to the right side of the corpus callosum, and extending partly into it, was an extravasation of blood of the size of a nut."³ The experiments of Fano upon dogs killed within a few minutes of their recovering consciousness after a stunning blow, show that in the absence of any other lesions most extensive congestion results. Duret's experiments, already quoted, are still more conclusive. Finally, in a case closely resembling that of Littré, already quoted, widespread congestion was discovered.

Arrested, and failing in his efforts to get away, the man dashed himself head-foremost against a wall, his hands being tied behind his back. He was picked up immediately afterwards, perfectly insensible, and died three-quarters of an hour after the injury.

¹ Œuvres de Sabatier, tome ii. p. 400.

² Mém. de la Soc. de Chirurg. de Paris, t. iii. p. 180. (Hewett.)

³ Hewett, op. cit., vol. i. p. 601.

As far as the brain itself was concerned, there was not even a speck of extravasation either on its surface or in its substance, the consistence of which was perfectly natural. But the intense congestion of the vessels of the brain gave rise to a manifest alteration in the color of its structures, its cut surfaces being thickly studded with the minutest blood-points, from whence specks of fluid blood oozed upon gentle pressure.¹

What, then, are we to conclude from such evidence as this? Surely, that there is probably no such thing as "cerebral vibration without visible lesion." Certainly my own clinical experience of cerebral concussion has led me to believe that there is some brain-lesion in every case of concussion, however slight it may be. Where no actual extravasation of blood takes place, the paresis of the vascular walls, which, as Duret has shown, follows the primary spasm, produces a congestion which may be evanescent—perhaps of only a few hours' duration—but which, I think, always exists.

Careful scrutiny of the histories and post-mortem records of an extended series of cases, has convinced me that in all cases of so-called concussion of the brain, we have in reality either a disseminated congestion of the organ, or contusion of some portions of its structure. Even in the slightest cases, we may have, as just shown, intra-arachnoid extravasation and ecchymosis of the brain-substance. It is time that the surgical mind should disembarass itself from the old magisterial views so long taught; since from erroneous views of pathology, bad practice is sure to ensue. The later symptoms of concussion usually detailed, are in reality those of either congestion, contusion, or laceration of the brain-substance—perhaps of all three. In accordance with the parts chiefly injured, so will be, in all probability, the symptoms, although no finely drawn diagnosis can commonly be made, owing to the probably extended nature of the lesions, and the interdependence of the various portions of the brain, both anatomically and physiologically. From these remarks, it must be clear that no table of distinctive symptoms can be given, whereby concussion and compression may be differentiated; since the so-called symptoms of concussion are really those of widely differing lesions of the intracranial contents, varying from a transient parietic congestion to cerebral ecchymosis and laceration. The exceeding variety, in fact the absolute want of constancy, presented by the symptoms of concussion, as to the pupils, the sensorium, etc., clearly indicates that we are dealing with different structural conditions, which the post-mortem room has demonstrated over and over again; yet a recent writer describes as a case of fatal concussion, one in which blood extravasation was discovered in the medulla oblongata.

Symptoms of Concussion.—Should the lesions be entirely or chiefly confined to mere temporary circulatory changes, the patient will probably be either unconscious, or only giddy, for a few moments after a head injury; will get up spontaneously, or with slight assistance; will experience bewilderment of mind; will be unable to collect his thoughts; will have a pale face; and will experience facial sweating, nausea, and perhaps vomiting. In a short time these symptoms will disappear, and the patient will be able to walk, with perhaps slight tremulousness of the limbs; and in a few hours he will be well. This is the rule; but the reader will recall a case just cited, where, with much less evidence of cerebral injury, marked contusion of the brain-tissue existed.

In severe cases, however, we have a much more serious condition. The patient is utterly insensible—pulseless, perhaps—with pallor of countenance, the only evidence of life being a hardly perceptible respiratory effort. The surface is cold, the limbs relaxed, the pupils normal or dilated, or one dilated

¹ Denonvilliers, *Compendium de Chirurgie*, tome ii. p. 606. (Hewett.)

and the other contracted, and, in any event, responding slowly, if at all, to light. Hemorrhage from the nose is said by Gross not to be an uncommon symptom, and even bleeding from the ears may occur in rare cases, without fracture. If recovery is to ensue, the respiration becomes re-established, at first feeble and intermittent, interrupted by sighing, and then, perhaps—according to the cerebral lesions—noisy or labored. The circulation is feeble and irregular. The urine is usually retained, although there may be incontinence both of urine and feces. The skin is bedewed with a clammy sweat, and the temperature is subnormal, from 94° to 97° F. The special senses are obtuse, the patient usually lying with wholly or partially closed lids, or, when the eyes are opened, apparently not noting visual impressions. By loud shouting and shaking, the patient may be aroused enough to open his eyes and answer in a few short words. This condition, usually described as that of shock or collapse, may last only a few minutes, or hours, or even days. Indeed, the patient may only partially react, to finally die of collapse, apparently, although post-mortem examination will usually reveal extensive brain lesions. If reaction takes place, vomiting is apt to occur, the pulse regains its tone and is less frequent and irregular, the skin becomes warmer and drier, the pallor of the face disappears—giving place perhaps to a flushed countenance—while the mental hebetude is succeeded by the normal condition, or by vertigo, headache, or delirium—in rare instances so violent as to require restraint.¹ Reaction may be succeeded by convulsions in children, and even in adults, or either a partial or general muscular tremor is observed.² The moment that reaction transcends a mere return to the normal state, the symptoms cease to be those of concussion—that is, the immediate effects of vibration of the intracranial contents—and at once become the expression of some damage inflicted upon the encephalon by the vibratory waves.

I might proceed to describe a variety of time-honored symptoms said by authors to be due to cerebral concussion, but the reader will see that I have already detailed symptoms which are indicative of extravasation of blood, either into the substance of the brain, or upon its surface. In conclusion, there is no symptom, or set of symptoms, *invariably* present in concussion of the brain. The pulse may be normal, slow, or frequent, and the respirations may be feeble, noisy, or stertorous, although the general account which I have given will apply to the majority of cases. The explanation of these variable phenomena lies in the fact that the cerebral centres of respiration, or of the heart, may be compressed, irritated, or partially destroyed.³ I believe with Sir P. Hewett, that many of the cases of concussion which have a prolonged convalescence, are in truth cases of extravasation within the arachnoid sac.⁴ I must again insist, at the risk of tediousness, that transient or persistent partial paralysis, loss of memory, etc., are not due to concussion—that is, to vibration of the brain-substance—but are the expression of some physical lesion of the cerebrum produced by that vibration.

The surgeon should be aware that, after reaction from concussion, convulsions and various brain maladies may set in, which, although apparently due to the injury, are, in many cases, merely a rekindling of old disease. Thus Callender relates a number of cases where old epilepsies

¹ Callender, St. Bartholomew's Hospital Reports, vol. iii. pp. 416–418.

² In one case of Callender's, what were supposed to be convulsive movements of the right arm were observed. One of the man's companions explained that he was only "steering his boat;" such facts must be kept in mind as explaining certain peculiarities of the delirium of concussion.

³ See Agnew, *op. cit.*, vol. i. p. 278; also Callender, *Anatomy of Brain Shocks* (St. Bartholomew's Hospital Reports, vol. iii. p. 415. 1867); and Remarks on the Principal Injuries of the Head, etc., in the Hull General Infirmary (*ibid.* p. 234).

⁴ See Hewett, *op. cit.*, vol. i. p. 602, for two conclusive cases.

returned temporarily with unparalleled violence, to again subside. Inquiry should always be made of friends or relatives as to the previous history of patients with head injuries. I lately assisted Dr. C. K. Mills and Dr. Healy in making a post-mortem examination of the brain of a young man, aged 19, who had been stunned by a horse-kick in the *face*, three weeks prior to his death. Upon opening the head, recent meningitis with serous effusion was found, and two small syphilitic tumors of the brain-substance. Here the concussion set up such a degree of congestion and irritation as to render fatal a disease of long duration, which had been quiescent and utterly unsuspected. The head symptoms were first noticed by the patient just about a week after the injury, that is, at the time that intracranial inflammation usually declares itself to the patient, although the physician may perhaps detect its onset at an earlier date.

Prognosis of Cerebral Concussion.—This should always be guarded. Rapid reaction, vomiting, restored intelligence, normal special senses, absence of severe or constant headache—especially if these negative symptoms persist for some days after the sixth, the usual time of advent of intracranial inflammation—are all encouraging symptoms. Prolonged collapse, relaxed sphincters, a weak, rapid circulation, progressive stupor, and heavy, labored respiration—that is, symptoms indicative of serious cerebral lesion—are almost certain harbingers of death. A relapse into stupor after regaining consciousness, repeated convulsions, and subnormal temperature, are bad signs. “Marked restlessness, screaming, and a rapid pulse,” Agnew thinks, are “infallible evidences of approaching death.” Excessive reaction, a full, rapid pulse, violent headache, delirium, and intolerance of light and sound, are—as indicative of impending, if not of actually present, intracranial inflammation—symptoms of the utmost gravity.

Treatment.—In the stage of collapse, warmth along the spine and to the feet, with sinapisms to the epigastrium, usually suffices. As we never can be sure whether we are not dealing with a case of intracranial extravasation of blood, or a contused cerebrum, stimulants must be resorted to as little as possible, since under such circumstances “a period of depression would be the safeguard of the patient.” (Hewett.) If, however, death seems impending, they must be cautiously resorted to.¹ I prefer hot coffee, which is a good cardiac stimulant, then carbonate of ammonium, and lastly alcoholic preparations, which, on account of their being more readily obtainable, are those upon which we most commonly have to fall back.² Prof. Gross recommends the use of stimulating enemata, such as those containing oil of turpentine, etc., but I have had no personal experience of their use in cerebral concussion. Whiskey or ether may be injected subcutaneously if the patient cannot swallow. After marked depression, marked reaction is apt to result, although they are not always proportionate.

Reaction within moderate limits should not be actively interfered with. Perfect quietude of mind and body should be enjoined. Ice, or evaporating lotions, should be kept constantly applied to the head, which, if the case be a serious one, should be shaved. The head and shoulders should be kept slightly elevated. A mercurial, followed by a saline purge, should

¹ As the senses are so obtuse, great care must be exercised in the administration of fluids by the mouth, lest they gain access to the air-passages, thus producing suffocation. The same may be said concerning strong smelling-salts, aqua ammoniac, etc., which it is often advised should be held beneath the patient's nose. Laryngeal spasm and subsequent irritation of the air-passages may result from their careless use.

² Stimulants, if given even in small quantities *at too short intervals*, may be unabsorbed in the stomach during collapse, to be absorbed as one large dose when reaction sets in, producing, possibly, a dangerous degree of cardiac action.

also be at once administered, and repeated when necessary. If there have been no serious loss of blood, water alone should be given for the first forty-eight hours, or, at most, milk with lime-water. As has already been pointed out, even with no other lesion there is intense cerebral congestion, rendering the affected parts of the brain of an obviously darker hue in those cases where death from other causes permits post-mortem examination. This clearly indicates what is the chief danger of these cases—viz., a distinct predisposition to inflammation, and against this probable result all our efforts must be directed. My invariable rule has been to treat the slightest cases of cerebral concussion as serious, and though much complaint on the part of the patients has resulted, I have never seen cause to regret the course pursued. Bleeding is never indicated in the stage of depression, and I have never had occasion to resort to it even in that of reaction.

At a later period, if there are marked delirium, fever, and flushed face, in a robust patient, bleeding from the arm or wet-cupping will prove beneficial. Some surgeons advise small doses of mercurials to affect the system. I see no objection to their use. Bromide of potassium or the deodorized tincture of opium, in repeated small doses, is useful for excessive restlessness or wakefulness. With the subsidence of the acute symptoms, or if exhaustion supervene, a more generous diet must be prescribed, with a cautious resort to stimulants. During convalescence, tonics are sometimes useful. The recumbent posture, gradually changed for the upright by pillows or a bed-rest, should be enforced for at least ten days or two weeks after apparent convalescence has set in.

II. CONTUSION OF THE BRAIN.—Bruising of the brain may be either circumscribed—the more common variety—or disseminated. In the slighter forms of circumscribed contusion, the injured part is seen to be of a dark-purplish color, this coloration being dependent upon numerous, closely-set, minute specks of extravasated blood no larger than pin-points. As the periphery of the ecchymosis is approached, the depth of coloration decreases, owing to the increasing dissemination of the minute extravasations. The cineritious portion of the brain is alone affected in this variety. The consistence of the brain seems but little, if at all, altered, as a gentle stream of water affects neither its color nor firmness. These remarks apply to an examination made within a short time of the injury.

The more severe cases have the central portions of the ecchymosis infiltrated with blood, so that they present a uniform, dark-purple color. Both the white and cineritious portions of the brain are involved. Instead of the pin-point extravasations, in the central portions, small clots of blood of varying size are found, while the periphery presents a series of smaller extravasations more and more widely separated. The cerebral structure is torn and disorganized, as shown by the effects of the impact of even a gentle stream of water, which loosens and washes away the clots, “leaving little pits with irregular and shaggy margins, and thickly studded throughout with pin-point extravasations.” (Hewett.)

Examined a few days after the injury, the bruised part will be found to present an irregularly depressed surface, with sharp, ragged borders. The surrounding brain-surface will be probably tinged yellow, with subordinate yellow circles surrounding the lesser extravasations. Either of these two forms of brain-contusion may be found alone, but they much more commonly coexist in the same brain. In the slighter cases, the meshes of the pia mater contain more or less extravasated blood in the form of small clots. The visceral arachnoid, with the pia mater, are usually torn in the more severe cases, in which event the cavity of the arachnoid contains extravasated

blood in varying quantity, besides that poured out into the meshes of the pia mater. Sir P. Hewett reports that in sixty-nine autopsies of more or less severe brain contusions, "independent of compound fractures," intra-arachnoid blood-extravasations were found in fifty-two, thirty-one of these being very extensive. In eleven cases, blood was found infiltrating the pia mater for some distance beyond the actual brain lesion, and in six instances "the extravasation was widespread." In the remaining six cases only, was the extravasation in the pia mater insignificant in amount, and limited solely to the site of the brain-injury.

The whole cerebral mass is not equally liable to contusion, some portions being almost constantly bruised in severe head-injuries, while others are so rarely affected as to be almost exempt. This statement is true as autopsies are usually conducted, but it is of importance to note that those portions of the encephalon said to be most rarely injured, such as the pons, crura, and medulla oblongata, may present at the autopsy no external evidences of injury, while careful sections will demonstrate well-marked spots of extravasation. From this fact I am inclined to think that many extravasations are overlooked, especially as Duret has experimentally shown that the floor of the fourth ventricle is peculiarly apt to be injured when severe blows are inflicted upon the head.¹ The medulla oblongata and the crura of the cerebellum and cerebrum are but rarely the seat of extravasations, and when so injured, intra-arachnoid extravasations are apt to coexist. The pons Varolii is an occasional but rare site of bruising.

The cerebellum is quite commonly contused, its under-surface being that portion which is usually injured. The ecchymotic spots are usually small, superficial, and confined to one lobe, although larger extravasations into the deeper parts have been observed, as in a case mentioned by Hewett, or as in one of Blandin's, where multiple minute spots were found scattered throughout the organ. These injuries are apt to accompany lacerations and contusions of other portions of the brain, although they may be occasioned by slight injuries, such as a drunkard's fall in the street.

The cerebrum is more commonly bruised upon its under surface than elsewhere. The extent of injury varies from a few patches of contusion to an extensive bruising of the entire surface of one, or even of two lobes at the same time.² Both the cortical and medullary structures may be extensively involved, to such an extent as even to lay open one of the lateral ventricles. The extent of injury done to the cerebral substance is not always commensurate with the degree of force applied. Thus, a case is reported, where, after a fall from a height of only about eight feet, extensive bruising and laceration of the anterior lobes of both hemispheres occurred, and produced a tear into the right lateral ventricle large enough to readily admit the finger. In addition, the deeper portions of the cerebrum may be bruised; and this, too, in some instances, without any injury to the exterior of the organ, or at least without injury corresponding in position to that of the deeper parts. Any portion of the brain is liable to injury, which may be so limited in extent as to escape anything but the closest scrutiny. The septum lucidum was in one case found bruised and torn for nearly its whole length, with spots

¹ A case is reported in the *Lancet* for Nov. 30, 1878 (page 769), from the practice of Verneuil, in which sudden death followed a severe head-injury, and in which the autopsy revealed sub-arachnoid hemorrhage at the "bulb and protuberance." On opening the fourth ventricle, a small central focus of hemorrhage was found in its floor, with two others, one on either side of the median line. These appearances are precisely those observed in Duret's experiments on concussion.

² The term lobe here is used in the sense of the older anatomists, where each hemisphere is divided into an anterior, middle, and posterior lobe.

of extravasation in the remainder of the septum, and in the back part of the fornix. No other brain laceration was found, although blood was poured out in small quantity into the arachnoid sac and pia mater at several points. I am thus particular in quoting cases—to which I shall presently add others—because they demonstrate how readily serious injury to the brain may be overlooked, unless the most minute and skilful *sectio cadaveris* be performed, and how the error of “concussion without cerebral injury” may be thus perpetuated. The only injuries in the cerebral mass which could be detected in another case, were a minute extravasation of blood in the edge of the fornix, a second upon its under surface, and “several specks” upon the surface of the thalamus. In addition, there were extravasations into the pia mater, over the posterior lobes of the cerebrum and the back part of the cerebellum. In still another case, an extravasation of the size of a nut was detected in the right centrum ovale, close to the corpus callosum. This coexisted with several thin layers of extravasated blood in the arachnoid sac. Finally, I would call attention to the post-mortem appearances presented in a fourth case, as illustrative of how serious the results of an apparently trivial lesion may be. Sir Prescott Hewett states that there is, in the museum of St. George’s Hospital, a specimen in which the ventricle was filled with blood from the laceration of a large vein, produced by a slight rent in the septum lucidum, which also involved the floor of the left lateral ventricle.

In the disseminated form of cerebral contusion, the foci of extravasated blood, instead of being grouped together, are widely diffused throughout the brain, involving not only the surface but the deeper portions of the organ. In rare instances, the deeper parts may be alone involved. The diffused form of contusion of the brain is a very rare affection, and one not easy of detection, being doubtless often passed by for want of a careful scrutiny of the parts. Diffused contusion of the brain presents itself in the form of minute foci of extravasated blood scattered through the cerebral substance. The size of the extravasations varies from that of the smallest pin-point to that of a split-pea. When of the latter size, the condition will hardly be overlooked, but with the minute variety, the spots are apt to be mistaken for the orifices of cerebral vessels. The two conditions can be readily differentiated by remembering that if the appearances are due to the gaping orifices of divided vessels, the specks can be readily wiped away, the spots reappearing if gentle pressure be made upon the brain. Miliary extravasations cannot be wiped away, and when picked out with the knife-point leave little depressions in the brain-substance. If examined within a short time after the injury, the brain-substance is normal in appearance around the extravasations, but when viewed some days after the accident, little greenish-yellow haloes will be seen around each spot; in other words, the appearances are those presented by a bruise of any other tissue.

Although there are usually numerous miliary extravasations, in some instances there may be so few that only a speck here and there can be detected after most careful search. In one recorded case, three very small extravasations were found in the left anterior lobe, a fourth small one in the fornix, and a fifth in the right lobe of the cerebellum. There were a few minute extravasations into the arachnoid and pia mater, but no fracture of the skull existed.¹ I hope that I have made it sufficiently clear that, whether circumscribed or disseminated, these extravasations are not the lesions of concussion, but of *contusion* of the brain. When diffused, they are the result of the sudden removal of pressure from the previously distended perivascular lymph-sheaths, tensely filled by the impulse impressed on the cerebro-spinal

¹ Hewett, op. cit., vol. i. p. 607.

fluid by the compressing force, which, as demonstrated by Duret, the blow exerts upon the elastic skull.¹ Oftentimes there is direct contusion beneath the part of the skull struck, but it rarely exists alone, being accompanied by ecchymoses in other parts of the brain, except when it is a direct result of the depression of fragments. In many cases the extravasation is directly opposite to the point struck, seemingly the result of counter-stroke. Direct contusion and that by counter-stroke are apt to coexist in severe head injuries.

The upper portions of the brain rarely suffer from contusion, for of thirty-six cases of fracture which started in the vault, but extended into the base, in only five was bruising of the upper surface of the hemispheres detected. (Hewett.) All portions of the base of the brain are not equally liable to be bruised. The middle lobes are those most frequently contused, the anterior ones less often, while the posterior are still more seldom injured. Of the thirty-five cases referred to by Hewett, the middle lobes were bruised in twenty-five, the anterior in eighteen, and the posterior in only four. In twelve of these cases, where the injury was exceptionally severe, both the anterior and middle lobes were contused. As to the reasons for this preponderance of injury in one part more than in others, I cannot accept Sir P. Hewett's and Sir B. Brodie's explanations, as they seem to me not sustained by anatomical considerations. In the *macerated* skull there are, indeed, a number of "irregular and angular projections," but in the *fresh* skull, I deny that they exist. In the section on fractures of the cranial base, I have tried to render these points clear, and to explain why the middle and anterior lobes are so commonly contused.

Symptoms and Diagnosis of Cerebral Contusion.—These are so uncertain as to render it exceedingly doubtful whether these lesions have any characteristic symptoms of their own. In the absence of fracture—probable or ascertained—after the first symptoms of shock have passed off, if there be pronounced unconsciousness, or marked somnolency, with the absence of stertor, or if there be extreme agitation and restlessness, it is exceedingly probable that contusion is present. If there be rigid contraction of one or more of the limbs, or of isolated groups of muscles, especially those of the fingers, the probability amounts almost to certainty. Now, if to these we have added marked isolated palsies, I think that we are justified in assuming the existence of contusion, provided that irritating lesions of the dura mater can be excluded. These, as I have already said, are more apt to occur on the side of injury—supposing this to have been produced by a circumscribed application of force—and never produce paralysis. Slight effusions of blood into the arachnoid sac are usually attended by no symptoms. Even when blood is effused in larger quantities, the symptoms are commonly those of compression of the brain-substance, not of irritation, and where both sets of symptoms coexist, I consider those of irritation to be due to concomitant brain-contusion. In mild cases of contusion, partial contraction of one pupil, partial paralysis of an eyelid, impaired vision, thick speech, slight spasmodic twitching of the facial muscles, one or all, have been noted. Unless there is evidence to the contrary, if after the application of severe diffused force to the skull, marked brain-symptoms—other than hemiplegia—persist after the shock has passed off, cerebral contusion and laceration will in most instances be found after death. I hesitate to thus differ from such a distinguished authority as Sir Prescott Hewett, recognizing, as I do, the fact that severe brain-bruising may exist without presenting any symptoms until several days after the injury, or indeed that they may be altogether wanting. But if, because the diagnosis is difficult, and because mistakes must sometimes occur when a positive

¹ See Duret's experiments, p. 53, *supra*.

opinion is ventured upon, the surgeon should be discouraged from making the attempt, he must abandon all hope of any further advance in the diagnosis of head injuries.

There is one variety of brain-bruising which I am confident that I have met with on a number of occasions, and which I shall now proceed to describe. To this condition Mr. Erichsen has applied the term "cerebral irritation." I have over and over again recognized the accuracy of his description. The probabilities are that in these cases the cortical matter of the brain is diffusely contused, and intensely congested—possibly the latter alone. The patient assumes a peculiar and most characteristic attitude, lying upon his side "curled up in a general state of flexion." The head is bent upon the chest, the trunk is bent forwards, the knees are drawn up on the abdomen, the legs are bent, and the arms flexed with the hands drawn in. The patient "does not lie motionless, but is restless, and often when irritated tosses himself about." "However restless he may be, he never stretches himself out or assumes the supine position, but invariably reverts to the attitude of flexion." He violently resists every effort to open the firmly closed eyelids, but, if this be done, the pupils will be found contracted. The skin is pale, cool, or cold; there is no heat of head; the pulse is slow—seldom above 70—small and feeble. The sphincters are usually unaffected, the patient emptying the bladder when it requires it, although retention of urine sometimes occurs. "Irritability of the mind is the prevailing characteristic." Unconscious, and paying no attention to what passes, when loudly called to, the patient "shows irritability of temper, frowns, turns away hastily, mutters indistinctly, and grinds his teeth." There is no stertor during sleep. After the lapse of from one to three weeks, the pulse improves in quality, the surface temperature increases, and the tendency to flexion subsides, the patient lying stretched out. Irritability of temper "gives way to fatuity," and the mind is evidently weak. Recovery is apt to be slow, but may eventually be perfect. Secondary complications may of course ensue at a later period. Erichsen says that "cerebral irritation" usually follows blows upon the forehead or temples, but the most marked instances which I have seen have been from injuries to other regions of the head.

Prognosis.—Contusion of the brain is a most dangerous injury, yet some cases end favorably. When recovery takes place, the contusion is repaired in the same manner as are apoplectic hemorrhages into the brain. In the slighter cases all traces may have disappeared, or a more or less dense cicatrix, with possibly some central coloring matter, may be detected, when death occurs independently of, and some time after, the injury. As an instance of the methods of repair in the more severe cases, Sir P. Hewett¹ thus describes the appearances seen in a case of extensive brain-contusion and laceration, twenty years after the accident:—

The convolutions of the anterior parts of both hemispheres of the brain were extensively excavated, and here the arachnoid and pia mater were carried evenly over both depressions, so that a space was inclosed beneath them, which was filled by loose areolar tissue and serum. In the right hemisphere, the mouth of the excavation was nearly circular, about an inch and a half in diameter, and so placed that the inferior margin lay close to the base of the brain, whilst the inner one was close to the median fissure. The depth of the excavation was about an inch, and the convolutions about its edge were natural. The cavity commenced, for the most part, abruptly, but one or two convolutions could be traced in a stunted condition down the walls, which had an even surface, and were loosely coated with areolar tissue.

In the corresponding part of the left hemisphere, there was also an excavation similar in all respects save that it was only about half the size of that in the right hemisphere.

¹ Op. cit., vol. i. p. 609.

The cerebral tissue, in the neighborhood of these cavities, and forming their walls, had a perfectly healthy appearance. There were no remains of blood extravasated in the cavity of the arachnoid; the other parts of the brain were perfectly healthy, and so, too, was the brain-case; no traces of fracture; no sign of injury to the bones. The patient died of aneurism of the subclavian artery, at the age of forty-eight, but twenty years before his death, when I was house-surgeon, he had been admitted into St. George's Hospital with several other men, all of whom had fallen a great height in consequence of the giving way of some scaffolding. At the time of his admission he was suffering from several severe injuries; and especially of the head, marked by the symptoms of so-called concussion of the brain, but there was no sign of fracture of any part of the skull. For several days he struggled between life and death, in a state of perfect unconsciousness, followed by violent delirium, which ultimately, however, subsided, and in a few weeks he was so far well that he was able to leave the hospital. After a while he resumed his occupation, that of a house decorator, and for years he worked for one of the best firms in London, and was known as one of their ablest workmen. His intellect was as clear as it had ever been, and when I accidentally met him, from time to time, he always said that he did not suffer more from headaches than other people.

Treatment.—The chief danger is that of encephalitis, against which all our efforts are to be directed. As inflammation of the brain and its membranes, after such injuries, is apt to pursue an insidious course, every head injury which presents indications that the intracranial contents have suffered even in a minor degree, should be most assiduously watched, as traumatic intracranial inflammation often suddenly declares itself, after a number of days of deceptive calm. Usually the incipient indications show themselves not later than the fifth day, but their advent is sometimes much longer delayed.¹ The therapeutic measures to be adopted are those recommended for warding off encephalitis, and when these efforts fail, those advised for intracranial inflammation should be instituted.

III. COMPRESSION OF THE BRAIN.—Any diminution in the capacity of the cranium must, from the presence of the cerebro-spinal fluid, exert an effect at all points occupied by that fluid. This increased tension compresses the vessels, and, by the consequent anæmia, causes disturbances of the functions of the encephalon. Theoretically, when this tension equals that of the blood in the vessels, death results. This point, probably, can never be reached except in experiments, as Duret has shown that the vascular spasm produced by irritation of the sensory nerves, or their centres, at once enormously increases the intra-vascular tension. He has shown that a clot amounting to one-twelfth of the cranial capacity, between the dura mater and the bone, will produce coma and death in a few hours. In the arachnoid cavity, however, a clot of one-sixth or even one-fifth the bulk of the cranial cavity is requisite for a lethal effect. These results are only true when no lesion of the nerve-centres coexists.

Although not by any means scientifically accurate, "compression of the brain" is a term so commonly used as to need no apology. Its causes are exceedingly various. Thus a foreign body, such as a bullet lodged in the brain, depressed bone, extravasation upon the surface or into the substance of the brain, and frequently all the last three, coexisting, may produce symptoms of compression which are then usually primary. Inflammatory products, viz., serum, lymph, and pus, are causes of secondary compression.

Symptoms.—Due as these are to such varied and often combined conditions, there are only a few symptoms which are always present. Before insensibility comes on, pain in the head is complained of, doubtless the result of pres-

¹ See section on Pachymeningitis, Arachnitis, etc., p. 74, *infra*.

sure and tension on the sensitive dura mater. The patient lies on his back in a more or less comatose condition, is unconscious, and breathes with a slow, stertorous respiration, often accompanied by a peculiar whiff at the corners of his mouth, as if he was smoking. The last-mentioned symptom appears to be due to paralysis of the cheek muscles, and is a sign of bad prognostic import. The pulse is full, and usually slow; the skin is cool, or it may be, as in one case which I recall, very hot and dry; or again, it may be hot and moist. The pupils are at first sluggish, and then fixed and immovable, being moderate in size, widely dilated, or one dilated and the other normal or contracted. This condition varies, as we have seen, with the part of the brain affected,¹ or with the presence or absence of intracranial extravasation of blood. There are retention of urine and fecal incontinence. There is paralysis of motion, usually affecting one side, but there may be right hemiplegia with spasmodic contractions of the left side, or only certain groups of muscles may be affected, according to the particular form of brain injury. General tremors or convulsions may occur. The most constant symptoms are coma, stertor, and paralysis. When death ensues, respiratory paralysis is the cause, whence the plain indication to resort to artificial respiration. The fundus oculi presents certain changes in well-marked cases of compression, such as venous stasis with relatively small arteries, and slight reddening of the papilla. Apoplexies of varying extent can sometimes be detected. Commencing *neuro-retinitis descendens*, with turbid redness of the papilla and indistinctness of its outline, may be noted, or—a very common form—stasis and oedema of the papilla, in addition to the neuro-retinitis; that is, “choked disk.”² These symptoms can only be detected in compression which lasts for some time, and usually result from the secondary compression exerted by pus—abscess of the brain, or diffuse suppurative cerebritis. When compression is due to a foreign body, or to depressed bone, the symptoms will be immediate, the patient being probably unconscious from the moment of injury. If the compression results from intracranial hemorrhage, it will come on gradually, in most cases after a distinct interval of consciousness, when the symptoms of concussion have partially or completely passed off. If due to cerebral contusion and parenchymatous hemorrhage, consciousness will not return after the injury, but the concussion-symptoms will steadily merge into those of compression. If resulting from the pressure of serum, lymph, or pus, the symptoms of compression will set in at a later period of the case, and commonly after distinct indications of intracranial inflammation.

Diagnosis of Cerebral Compression.—From what has been said concerning concussion and compression, it will be seen that in most severe cases the distinction cannot be made, since the symptoms are oftentimes produced by similar injuries, the two conditions presenting differences only of degree. Concussion in its first stage has no definite symptoms beyond those of shock and syncope—which may be also present at the incipency of compression—while if extravasation or cerebral contusion exist to any marked degree, symptoms resembling those of compression will probably present themselves almost from the outset. Slight causes of compression, such as a limited depression of bone, or small extravasations of blood, may produce only evanescent symptoms, the brain soon accommodating itself by virtue of its displaceable cerebro-spinal fluid. Thus in many cases no positive diagnosis is possible, since, as investigation has shown over and over again, no one diagnostic symptom can be implicitly relied upon. Of course, when a patient suffers from profound

¹ See Concussion of the Brain, *supra*; also Leyden's experiments, Ziemssen, *op. cit.*, vol. xii. p. 666.

² See section on Cerebral Abscess, p. 80, *infra*.

coma, with hemiplegia, dilatation of one pupil, stertorous respiration, etc.; or when he recovers consciousness after stunning, to again relapse into coma, with hemiplegia, etc., we can confidently pronounce the cause of the trouble to be compression. Those who see many severe head-injuries, and the results of post-mortem examination, will concur with me, I am sure, in expressing the opinion that it is eminently misleading to the younger practitioner to authoritatively tabulate the diagnostic symptoms of compression and concussion. It is a relic of ancient magistral surgery which it is time should be dispensed with.

Prognosis.—This depends upon the cause. If slight, the patient regains consciousness and recovers. In other instances the cause may be a removable one, when, if the concomitant cerebral injuries are not in themselves mortal, recovery often ensues. The later forms of compression of the brain by lymph and pus, are peculiarly grave, and unless remediable by the surgeon's giving them free vent—and too often then—they sooner or later destroy the patient.

Treatment.—This has been so fully dwelt upon under various other heads, that I need only refer the reader to the sections on intracranial hemorrhage, intracranial abscess, foreign bodies in the brain, fractures of the skull, etc. I would however call attention to the possibility of resuscitating a patient even apparently dead from respiratory failure, after the cause of compression has been removed, by means of artificial respiration, the hypodermic use of atropia, and electrical stimulation of the diaphragm. This sudden respiratory failure is more common than is ordinarily supposed.¹

IV. LACERATION AND PROTRUSION OF BRAIN-SUBSTANCE; *HERNIA CEREBRI*.—Bruised and lacerated fragments of brain-tissue may be driven through a fracture situated in any part of the skull, but such injuries are usually the result of compound fractures of the vault, the force producing which at the same time ruptures the meninges. Very rarely the brain-substance is extruded through a basal fracture of the skull, in direct communication with the ear, nose, or pharynx. Brain protrusion would occur more commonly with fractures of the base, were it not that they usually consist of mere fissures of the bone, without any laceration of the dura mater. When such an accident does occur, it must necessarily be, with rare exceptions, fatal, from the violence of the force producing it, and from the consequent intracranial damage.

Hewett reports a case seen at St. George's Hospital, London, where a profuse hemorrhagic flow from the left ear, containing fragments of brain-substance, resulted from a fall upon the vertex, from a great height.² Two other similar cases are referred to by him, the original histories³ of which I have carefully perused, and which I find closely resembled that above mentioned. I am acquainted with only three recorded cases where brain-matter has been forced through the nostrils, and in one of these recovery followed.⁴ I append brief notes of two cases of recovery after protrusion of brain-substance.

A man, aged forty years, fell from a scaffold, a height of twenty feet, striking with his head some iron bars; he was stunned, but upon admission to the hospital, half an hour later, he had recovered consciousness. There was a small wound over the right eyebrow, sticking in which was seen a fragment of brain-substance. There was slight

¹ See Cerebral Abscess, p. 80, *infra*.

² Op. cit., vol. i. p. 610.

³ Journ. de Méd. et de Chirurg., tome iii. p. 454. 1779; and Annales de Chir., tome viii. p. 229. 1843.

⁴ Compend. de Chirurg., tome ii. p. 595; Bull. de la Soc. Anat. de Paris, p. 228. 1837; Am. Jour. Méd. Sciences, April, 1859, p. 354.

hemorrhage from the right nostril, while the pulse and respiration were undisturbed, and only some pain in the head was complained of. The next day a fragment of the brain, of the size of a hazel-nut, together with some blood-clot, escaped from the right nostril. The inner wall of the frontal sinus had been broken, which afforded a means of exit for the lacerated brain.¹

A seaman, on board the United States ship *Constellation*, fell from the mast-head through a hatchway, landing full upon the vertex. Copious bleeding from the ear, estimated at from 50 to 60 fluidounces, occurred within a few hours, and mingled with the blood were small fragments of brain-tissue. This was followed the next day by a free watery discharge from the auditory meatus, in which were found several small pieces of true brain-substance. In five weeks the man had returned to duty, only complaining of giddiness and a "stuffed-up" head.²

After an extensive search through the literature of the subject, I can find no record of brain-substance having been forced into the pharynx; but Hewett says that he has seen the contents of the pharynx within the skull, to which they had gained access between the widely separated fragments of a fracture of the cranial base.

Prognosis.—As just said, nearly all cases in which cerebral protrusion occurs at the base of the skull, terminate fatally; but when the vault is involved, although the injury is a most dangerous one, it is not necessarily mortal, since the records of surgery contain a large number of instances where recovery has ensued after losses of considerable portions of brain-tissue—recoveries, too, in many instances, without any apparent sequelæ, either mental or physical. I have been present myself at an operation, performed by another surgeon, where several teaspoonfuls of brain-substance were lost, and where yet the patient made a good recovery. Two high authorities are diametrically opposed to each other as to which is the most dangerous region for these injuries, Brodie³ saying that he could discover no record of recovery where the posterior lobes of the cerebrum were involved, while Guthrie thought that an injury of the forehead was far more dangerous than one of the back of the head, and that injuries of the side or middle of the cranium occupied a mean place as to their mortality.⁴ I am unable to throw any light upon this vexed question, but am inclined to think that each case must be considered by itself, and that all generalizations must be fallacious where the lesions are so exceedingly varied.

Treatment.—This must be that of other severe head-injuries, with special reference to the probability of the formation of secondary protrusion of the brain-substance, or *hernia cerebri*.

Hernia Cerebri.—In the great majority of cases, this protrusion consists largely of true brain-substance. This has been proved macroscopically—in one case of Mr. Stanley's the cortical and medullary substance were readily distinguished by the naked eye—and microscopically, as in Mr. Hewett's case, where "many nerve-tubules were detected in every portion thus submitted to the glass." In some cases the mass has been described as consisting chiefly of blood effused beneath the pia mater, while in others the tumor has been found to consist of a mass of hyperplastic granulation-tissue. Although almost always the result of a fracture with consequent rent of the dura mater, or when that membrane has been purposely or accidentally opened during an operation, *hernia cerebri* may result from syphilitic caries, as in two recorded

¹ Medical Gazette, new series, vol. iii. p. 77. 1846.

² Amer. Jour. Med. Sciences, April, 1859, p. 354.

³ Med.-Chirg. Trans., vol. xiv. p. 421.

⁴ Guthrie, *Injuries of the Head*. Commentaries on the Surgery of War, 6th edit., p. 284.

cases.¹ The opening through the dura mater may be primary, or may occur at a later date from sloughing of that membrane. The presence of splinters of bone, piercing and irritating the dura mater, seems peculiarly apt to give rise to hernia cerebri. The time of its appearance is most various. It may be quite voluminous, as I have seen it, within twenty-four hours, or it may not appear until the sixty-eighth day;² but in most instances it has been first noticed from the fifth to the seventeenth day, that is, when inflammation has set in and is well under way. Large portions of the cerebral substance may be destroyed, as in a case of M. Bouchacourt,³ where the lateral ventricle was laid open—as shown before death by the large quantities of limpid fluid which came from the wound, and after death by direct examination. There is often a great apparent loss of brain-tissue before death, when at the autopsy but little cerebral substance is found to have been destroyed; which shows that much of the protruded mass, in certain cases, must have consisted of granulation-tissue, extravasated blood, infiltrated serum, etc. The swelling is usually painless on pressure or incision, although in a few cases evanescent pain has been complained of when the mass has been cut away. The subjacent brain-substance is soft, swollen, and œdematous, and the whole brain is often infiltrated with serum, and contains abscesses, or the ventricles may be filled with large quantities of fluid; all these conditions may coexist. Extensive intra arachnoid and sub-arachnoid effusions of pus and lymph are commonly found. Although, in a general way, the truth of Guthrie's statement is borne out by experience, that protrusion of the brain-substance is more apt to take place when there has been a limited removal of bone, yet M. Bouchacourt's⁴ case, and two others mentioned by Hewett, prove that the contrary may be true. As in the case of primary brain-protrusion, from the rarity of gaping of basal fractures and consequent rupture of the dura mater, hernia cerebri rarely occurs except in the vault of the skull. With the necessary pre-requisites, however, that is, removal of pressure by destruction of the bone and dura mater, secondary brain-protrusion may occur at the base. Thus, a boy under the care of Mr. Cæsar Hawkins received a pistol-ball wound through the right malar bone, with lodgment of the missile in the head. There were no marked cerebral symptoms for seven days, when he became restless and delirious. That afternoon a soft fungus showed itself in the wound, and he died thirty hours later. Post-mortem inspection revealed a large gap in the sphenoid and temporal bones, through which quite a large mass of brain-substance projected. The substance of the brain around the protrusion was vascular, and of the yellow color usually found in such cases.⁵

The tumor, pressing its way externally, when it reaches the level of the cranial walls, tends to spread mushroom-like over the contiguous scalp. Its surface is irregularly indented, soft and discolored with blood, or gray and firm. The protrusion may be only moderately vascular, or may be most abundantly supplied with blood, and may pulsate synchronously with the brain. Portions are apt to slough away from time to time, so that in some cases the whole tumor may drop away piecemeal, cicatrization of the wound, and cure, following; or again, *pari passu* with the sloughing away of portions of the growth, new protrusion may take place, until the patient finally dies exhausted. In one case reported by Quesnay, the patient tore the whole mass away, a cure resulting. Finally, without sloughing, the hernia may gradually shrink, and totally disappear.⁶

¹ Med.-Chirurg. Trans., vol. viii. p. 45. Gross, op. cit., vol. ii. p. 78.

² Laurie, Lond. and Ed. Monthly, June, 1844, p. 478.

³ Bull. de la Soc. Anat. de Paris, tome xiii. p. 13.

⁴ Loc. cit.

⁵ Hewett, op. cit., vol. i. p. 612.

⁶ Laurie, loc. cit.; Crawford, Edinb. Med. and Surg. Journ., vol. xii. p. 22.

Pathology.—The removal of pressure, in conjunction with softening of the cerebral tissue, renders a very slight increase of intracranial tension efficient as a cause of protrusion of a portion of the brain-substance. This is shown by cases where it has followed cranial necrosis. In all other parts, a hyperplastic induration of the connective tissue commonly takes place, whereby pus, if it forms, is limited. In the brain-tissue, the delicate neuroglia readily allows of infiltration with inflammatory products, and its acute hyperplasia, instead of strengthening, seems to weaken the tissue, so that the brain readily yields to the least pressure. Now intracranial inflammation with cerebral softening is usually present at the time when hernia cerebri makes its appearance, and at a stage, too, when free effusion into the ventricles, arachnoid sac, and substance of the brain, is prone to occur. In those rarer cases which occur within the first forty-eight hours, I would suggest that the condition is probably due to the parietic dilatation of the vessels observed in concussion, which is, as pointed out by Prof. Agnew,¹ commonly followed by free exudation of bloody serum.

Symptoms.—They are those of inflammation of the brain and its membranes, and therefore need not be dilated upon. It is interesting to note that there may be almost a complete absence of all symptoms beyond slight rambling of speech, occasional twitching of the facial muscles, broken sleep, and a full pulse. Not unfrequently the patient dies of pyæmia.

Diagnosis.—This can hardly be confounded with any other affection except the “tumeur hématique” of Velpeau, which arises from a mere effusion of blood upon the outer surface of the dura mater. I do not know of any special diagnostic points, but as such tumors are among the great rarities of surgical practice, they can but rarely give rise to mistakes.

Prognosis.—Although a very fatal complication, recovery does occasionally ensue. Thus, of 80 cases which I have collected, 25 ended favorably, and 55 in death. Of the patients who recover, the majority suffer from vertigo, headache, etc. I do not presume to say that such a small number of cases settles the percentage of mortality, but merely give the figures for what they are worth, as a lethal issue is commonly quite as much the result of concomitant injuries, inflammation, etc., as of the hernial protrusion.

Treatment.—In general, the less done the better. As the cause is primarily loss of support, gentle pressure at the outset, with the use of some antiseptic absorbent dressing, may be advantageously tried. The parts should be frequently cleansed with some antiseptic astringent wash. Removal by the knife, tearing, or ligature, must in general be avoided, especially where granulations are springing upon or around the protrusion, as we should thus still further remove pressure and encourage the growth. The removal of protruding brain-masses is rarely, if ever, effectual, and experience shows that they at times disappear spontaneously. As the intracranial inflammation, in most instances, stands in a causative relation to hernia cerebri, appropriate treatment for that condition is indicated. Great care should be exercised to remove, when possible, all fragments of bone which may irritate and injure the dura mater and brain. Mallet, Hewett, and other surgeons report a number of apposite cases where bony fragments, by causing sloughing of the dura mater and irritation of the brain, have apparently favored the formation of hernia cerebri. Special attention should be paid to the state of the circulation, which, if over-excited, must be controlled by appropriate remedies. This is, however, as pointed out by Laurie, rarely the case.

WOUNDS OF THE BRAIN AND MENINGES.—According to the nature of the vulnerating body, these may be incised, punctured, lacerated, contused, or

¹ Op. cit., vol. i. p. 277.

gunshot wounds. The contused and lacerated varieties may be produced without fracture of the skull, but this accident almost necessarily precedes the more severe forms.¹ Punctured wounds may be caused by spicules of bone driven down into the substance of the organ, but most frequently result from thrusts with penknives, forks, dirks, pointed pieces of wood, nails, ferules of umbrellas or walking canes, etc. Those portions of the skull most often perforated are the orbital plates of the frontal bone and the cribriform plate of the ethmoid, although in young children any portion of the skull may be thus injured. Gross states that a bad punctured fracture sometimes results in children from a blow by the spur of an enraged cock.² The brain has been traversed from one extremity to the other by balls, swords, bayonets, ramrods, etc. In one case reported by Larrey, a ramrod passed through a soldier's head without wounding any important structure:—

A metal ramrod entered the head of a soldier in the middle of the frontal bone, making its exit upon the left side of the neck, and was so firmly imbedded as to defy all efforts at removal. After death, the missile was found to have passed between the cerebral hemispheres without wounding them, but tearing the falx; after which it pierced the body of the sphenoid bone, and finally emerged through the occipital bone near the foramen magnum. This patient lived two days.³

Incised and punctured wounds of the brain, when small and clean-cut, may, according to Rokitsansky, sometimes heal by adhesion. In minor degrees of contusion, repair is effected as in ordinary apoplexies.

A superficial mortification of the contused parts may occur, the extent of the process depending upon the degree of the contusion. If slight, the processes peculiar to red softening occur at the points of injury and in the surrounding tissue. When the bruising is more severe, a dark-brown, pulpy mass is apt to be found in the centre of the injured spot, around which is seen a broad zone of intense congestion, with numerous capillary apoplexies. Outside of the belt of congestion, one of inflammatory œdema will be detected.

In other instances, acute, diffused, superficial suppuration occurs, which is invariably accompanied by meningitis. The suppuration is not limited to the surface contusions, but a number of small abscesses are grouped around the superficial one.

A contusion of the brain-substance which results in encephalitis, may not end in suppuration but in yellow softening. This is especially true in regard to contusion of the punctiform variety. Here the initial necrotic changes are more pronounced than those of inflammation; hence the appearance of yellow softening. In many cases further changes take place. The softening may extend until large portions of the brain are involved. This is rendered possible by the border zone of œdematous brain-tissue, wherein the nerve-elements already have their nutrition seriously impaired. Even with compound fracture of the skull, neither inflammation nor yellow softening invariably occurs, when the contusion consists simply of capillary apoplexies. After death, these injuries, when the patient survives some time, are evidenced by a slight thickening around a small collection of fat granules, granule-cells, and hæmatoidin crystals. Finally, slight contusions may—in very rare instances where the skull is not opened—result in circumscribed yellow softening, without any trace of inflammation. These spots of softening may give rise to no trouble for prolonged periods, and then unfortunately, under entirely unknown con-

¹ See sections on Contusion of Brain and Fracture of Base of Skull.

² *Op. cit.*, vol. ii. p. 76.

³ Larrey's *Mem. Mil. Surg.*, vol. ii. p. 313. Am. ed. 1814. I need hardly do more than refer to the famous case recorded by Harlow and Bigelow, in which a tamping iron, weighing over 13 pounds, was blown through a patient's head, and yet recovery ensued.

ditions, a rapid extension may set in and terminate fatally. The clinical history of these cases of consecutive softening is not clear, and closely resembles that of brain-abscesses.

Wounds producing loss of substance heal by granulations, which fill up the cavity, adhesion taking place between the resulting granulation-tissue and the cicatrix which closes in the opening through the bone and meninges. Rokitsansky shows that, under these circumstances, the lateral ventricle on the side of injury enlarges, to partially supply the place left by the loss of cerebral tissue.

At a later period, the brain tends to sink inward, and by this process of stretching of the cicatrix, a loose connective tissue, with its interstices filled with a serous fluid, comes to lie between the brain and the superficial scar, where the two structures were formerly firmly bound together.

Prognosis.—This is dependent upon the portion of the encephalon wounded, and upon the concomitant injuries. With a limited lesion, and one not compromising the integrity of the involved brain-tissue, recovery is possible, and indeed under judicious treatment has often taken place readily. Recovery is also compatible with destruction by bruising and tearing of large portions of the brain-substance, although the danger is usually proportionate to the extent of tissue involved. Large portions of brain may be lost, and yet, provided that neither the motor area nor that of speech be involved, no apparent loss of intellectual power nor disorder of motility may be detected.

The preceding remarks are chiefly applicable to injuries of the superior and lateral surfaces of the hemispheres, for if wounds involve the base of the brain, or the medulla oblongata, the respiratory centre may be involved, when instant death from cessation of breathing will occur. Even when those centres which are immediately necessary to life are not at first involved, they generally become affected sooner or later, either by contiguity of structure or from pressure of inflammatory products, when death follows.

Should recovery take place after basal injuries, it usually does so with marked impairment of the mind, and varied palsies of motility and sensation. The special senses also are apt to be lost or impaired. Nothing like certainty in prognosis is possible, as the most frightful injuries may be recovered from, while the most trivial may result in death. In the words of Percival Pott, however, "no injury is too great to be despaired of." The chief dangers to be apprehended are encephalitis and hernia cerebri.

Symptoms.—These are so dependent upon the portions of brain involved, that it would be useless to attempt to detail them.

Wounds of the meninges are always grave, indeed often as fatal as wounds of the brain itself. Suppuration and sloughing of the dura mater generally follow contused wounds, with a consequent, diffused, intracranial inflammation, and in very many cases hernia cerebri results. These evil consequences are peculiarly apt to follow from the irritation caused by depressed splinters of the inner table, whence arises the practical precept to remove these by operation, when such untoward results may oftentimes be avoided.¹ A portion of dura mater which might have recovered its vitality if the pressure and irritation of bony fragments had been removed, is too often "left to nature" as it is said, and with fatal consequences.

Extensive incised wounds of the meninges, removing considerable portions, as in sabre wounds where large segments of the cranium have been sliced off, not infrequently end in recovery, as in cases reported by Hennen,² Larrey,³ and others.

¹ See section on *Hernia Cerebri* for the influence exerted by bony spicules in causing this affection.

² Hennen, op. cit., p. 231.

³ Larrey, op. cit., vol. ii. p. 281.

Treatment of Wounds of the Brain and Meninges.—This should embody the prophylactic and curative measures appropriate for encephalitis, to the section upon which subject the reader is referred.

FOREIGN BODIES IN THE BRAIN.—Foreign bodies may become encysted, either actually imbedded in the cerebral tissue, or merely lying in contact with the exterior of the brain. Their usual tendency is sooner or later to induce fatal inflammation, even after years of immunity from all trouble. Foreign bodies like bullets, may remain lodged in the brain for years, when a drinking bout, or some extraordinary mental excitement, may bring about sudden death. (Quesnay, Henken, Wharton.) “In a case observed by Dr. John E. Gibson, of Nashville, the ball remained in a quiescent state in the anterior lobe of the brain for six years, when it excited fatal inflammation.”¹

In an admirable paper by Dr. H. R. Wharton, of Philadelphia,² published in 1879, that surgeon gives an analysis of 316 cases where a foreign body was lodged in the brain. Of this number, one hundred and sixty ended in recovery, while one hundred and fifty-six proved fatal. The influence upon recovery of the removal or retention of the foreign body was most marked. The foreign body was removed in one hundred and six cases, seventy-two patients recovering, while only thirty-four died. In the remaining two hundred and ten cases, no attempt at removal was made, and recovery took place in only eighty-eight cases, while one hundred and twenty-two patients died. A further analysis shows that among those classed as recoveries, death ultimately took place in ten cases at periods varying from three to fifteen years, and that many of the patients suffered from such after-effects as vertigo, incapacity for physical exertion, loss of sight or hearing, epilepsy, and deterioration of the mental powers.

Still further, of those cases in which the patients recovered without manifesting any of these sequelæ, numbering in all one hundred and eleven, the foreign body was removed in fifty-six cases, and allowed to remain in forty-five. The evil results of allowing a foreign body to remain in the brain are usually manifested sooner or later—even as long as thirteen years after the injury. Inflammation, slow or rapid, sometimes involving large portions of the brain tissue, or yellow softening, is apt to be set up around the foreign substance, either spontaneously, so to say, or from the most trivial exciting causes.³ The usual termination is cerebral abscess, this condition having been found in fifty-three of Wharton's cases, in which a post-mortem examination was obtained. Apoplexy is an occasional cause of death, as is pressure of the foreign body on the venous trunks, inducing ventricular effusion and consequent compression of the cranial nerves. Convulsions, coma, etc., have also been thought to have originated from venous pressure. The probable explanation of those cases in which no symptoms have been present for long periods, but in which death has rapidly followed upon the sudden development of brain-symptoms, is that quoted by Wharton from Flourens. The latter observer introduced bullets into different portions of the upper parts of the hemispheres, and upon the cerebellar lobes of dogs and rabbits. By their own weight the balls gradually penetrated the brain-substance, ultimately reaching the basis cranii, the bullet tracks healing after them. In man, something analogous probably takes place, thus accounting for the late supervention of rapidly fatal symptoms.

As to the fatality of wounds of the different portions of the brain, fifty-

¹ Gross, op. cit., vol. ii. p. 73.

² Phila. Med. Times, 1879.

³ Drinking, mental excitement, or slight injury caused seven deaths among the fatal cases in Dr. Wharton's table.

eight deaths took place out of one hundred and thirty-two cases where the foreign body entered through the frontal bone. Fifty-eight wounds of the parietal showed twenty-seven deaths and thirty-one recoveries. The occipital bone was penetrated twenty-three times, with sixteen deaths and seven recoveries. The temporal bones were penetrated in thirty-one cases, with twelve deaths and nineteen recoveries. Orbital wounds were very fatal, only one recovery taking place out of eighteen cases. Four deaths took place out of five cases of penetration of the sphenoid bone. I admit that a penetrating wound of any special cranial bone does not exclude injury of portions of the encephalon far distant from that immediately subjacent to the perforation of the skull, yet, as in many cases the foreign body was removed, only the brain contiguous to the point of penetration must have been compromised, and I therefore consider Dr. Wharton's analysis of considerable value in determining the relative mortality of wounds of different parts of the brain. Indeed, it is only in accord with what the physiology of the different portions of the encephalon would indicate.

Treatment.—From what has been said as to the increased chances of recovery, and as to its completeness, after removal of foreign bodies lodged in the brain, when contrasted with the results of non-interference, it must be clear that whenever an extraneous substance can be removed without too much destruction of tissue, it should be done. The difficulty of locating a foreign body in the brain is very great, owing to the ease with which the probe gets out of the track of the vulnerating body by penetrating the healthy cerebral substance. Great care should therefore be exercised in the use of the ordinary probe. A soft—not flexible—catheter may be used with comparative safety; by resorting to this instrument, Larrey successfully detected and removed bullets in the two following cases.

A soldier received a musket-ball wound in the middle of the frontal bone near the sinus, which passed between the cranium and the dura mater, and along the longitudinal sinus to the occipital suture. It produced all the symptoms of compression. Larrey, inferring the location of the ball from the patient's complaints of pain at a point diametrically opposite to the wound, introduced a gum-elastic sound until he touched the bullet. By measurement, the portion of the cranium beneath which the ball lay was exposed, a large trephine was applied, pus was evacuated, the ball was removed from between the dura mater and brain, and recovery ensued.¹

A ball penetrated the left parietal eminence of a soldier, passed obliquely along its inner surface, and was arrested about one centimetre from the occipital suture. The presence of a slight ecchymosis near this spot, the symptoms, and the employment of a small soft sound, induced Larrey to lay bare the bone, when he found a small fissure, applied a large trephine, and removed a piece of the bullet. The patient did well for five days, and then died of a fever.²

Now of course I do not advise the surgeon in every case of lodgment of a foreign body in the brain, to imitate Larrey, but I simply relate the cases to show what skill, boldness, and good fortune will sometimes effect, and to prove that apparently perforating wounds of the brain itself may be only so in seeming, so that a careful examination in suspected cases may reveal a more favorable condition admitting of operative interference, which may turn the scale towards the side of recovery. As already remarked, a silver probe should be used, if at all, with the utmost care; it is better to resort to a small, soft rubber, or French, sound or catheter, and even with such an instrument, to examine with judgment, and not make persistent efforts to locate the foreign body, since patients may recover with permanent lodgment

¹ Op. cit., vol. i. p. 307.

² Ibid., vol. ii. p. 170.

of extraneous substances. For the methods of extracting such objects, I would refer the reader to the section on trephining.

PACHYMEMINGITIS, ARACHNITIS, AND CEREBRITIS.—Any injury of the head may give rise to intracranial inflammation, but some are more apt to produce such an untoward result than others. Thus, lesions of the brain-substance are more frequently followed by inflammation than scalp-wounds and injuries of the bones. When intracranial inflammation arises from a scalp-wound, where the vulnerating body has injured none of the cranial contents, it is always due to a complicating erysipelas or diffuse cellulitis. Under these circumstances, cerebral symptoms not uncommonly manifest themselves. The post-mortem examination of cases fatal from such complications, usually reveals nothing beyond an increased vascularity of the pia mater, with effusion of opaque fluid in the subarachnoid tissue over the upper surfaces of the hemispheres, and marked congestion of the cerebral substance itself.

When the disease starts in the bone or its coverings, the inflammation spreads inwards, first involving the dura mater, then the parietal arachnoid, the visceral arachnoid, next the pia mater, and finally the cortex of the brain. Examining the different tissues involved, it will usually be found that, in the acute forms, especially in those arising from osteo-myelitis after bone injury, the dura mater becomes infiltrated, and its outer surface smeared with lymph or pus; it may even slough. Although the inflammation, as far as the dura mater is concerned, is almost invariably confined to that portion of the membrane which lies immediately beneath the diseased bone, yet this is not always the case, as it tends in exceptional instances to spread along the cellular coat of the meningeal arteries until the disease reaches even the base of the skull.

When inflammation of the dura mater results from chronic mischief set up by traumatic osteitis, caries, or necrosis, the membrane is apt to be thickened, more vascular, and closely adherent to the bone. Rokitsansky states that under these circumstances either bony plates may be developed, which become fused with the cranial bones, or osseous concretions may be formed in the dura mater itself, which often in time co-ossify with the adjacent part of the skull.¹ As the parietal arachnoid is, histologically, really a part of the dura mater, in the acute cases the inflammation soon involves the former tissue, when the disease usually becomes rapidly widespread. This is the rule, but Hewett relates one case where the effusion of pus and lymph upon the arachnoid was exactly limited to the diseased area of the dura mater.

Traumatic arachnitis, as it usually appears, involves the upper and lateral surfaces of both hemispheres, although only the surface of that which corresponds to the bone injury may be affected. Sometimes the surfaces of both hemispheres may be involved without any effusion at the base of the skull. In the majority of cases the arachnoid cavity contains a large amount of a yellowish, or greenish-yellow, fibrinous, or purulent exudation. In rare instances adhesions take place between the opposite lymph-coated surfaces, and the purulent matter becomes circumscribed, forming an apparent cerebral abscess. Thus De la Peyronie,² Soulier,³ and others have reported cases where the pus extended alongside the falx as low down as the corpus callosum. S. W. Gross has collected a number of cases where circumscrip-

¹ Rokitsansky, *Manual of Pathological Anatomy* (Sydenham Society's edition), vol. iii. pp. 324-326.

² *Œuvres de Sabatier*, tome ii. p. 452. 1796.

³ *Mém. de l'Acad. Roy. de Chir.*, tome i. pp. 210. Paris, 1743.

tion of the arachnoid effusion has taken place.¹ Hewett says that he has seen at an autopsy one case where the pus was thus circumscribed, the fluid running down between the falx and left hemisphere as far as the corpus callosum.

The next tissue attacked is the pia mater, which is usually extensively infiltrated with the same greenish-yellow, puriform or plastic exudation that I have described as occupying the arachnoid sac. In one very severe case, the pia mater had become so thickened that it could be removed "whole from the brain, and with its prolongations, which dipped down between the convolutions," looked "as if it had been cast in wax."² The inflammation is usually limited to the pia mater of the convexity of the hemispheres, although this is not an invariable rule. The subjacent cortical brain-tissue is frequently dark and discolored, and so softened as oftentimes to permit adherent fragments of brain-substance to come away with the pia mater, even when the latter is removed with the utmost care.³ The whole thickness of the cortical portion of the brain may be involved, or only a thin stratum of its periphery, while the white substance is entirely unaffected except by simple congestion, as evidenced by the larger size and greater number of its vascular puncta.

As exceptional conditions found after death from meningitis resulting from injury of the skull or its coverings, I may mention that, with pus between the bone and dura mater, the arachnoid sac upon the side of injury has been seen to contain purulent lymph, covering the posterior third of the upper and lateral surface of the hemisphere, with entire absence of sub-arachnoid effusion.⁴ This is a very uncommon condition. In another case, with the dura mater covered with adherent lymph, and "matter running from thence along the branches of the middle meningeal artery down to the base of the skull, no effusion was found in the arachnoid cavity," while sero-purulent fluid was found in large quantities in the subarachnoid tissues covering the whole of the corresponding hemisphere.⁵

I would here call attention to the interesting fact that, while it is the rule to find inflammatory effusions in the arachnoid sac when the disease is due to traumatism of the bone, meningitis from brain injury resembles the idiopathic form of inflammation, in that the arachnoid cavity is in the majority of cases free from effusion.

If the morbid appearances of the membranes after contusion⁶ of the brain be examined, the exudation will be found chiefly if not entirely in the pia mater, which, it infiltrates to a varying extent. In those cases alone in which the inflammatory process is of an exceptionally high grade, does the effusion take place into the arachnoid cavity. When purulent, the effusion into the pia mater is not infrequently of a decidedly green color.

There are then two kinds of traumatic inflammation of the meninges, in which the primary source of the disease affects first the membranes nearest to it. Thus, when the bone is the starting point, the dura mater becomes affected, and, as a consequence almost without exception, the free surface of the arachnoid. Originating in the cerebral substance, the inflammation attacks the pia mater, to which it is confined, except when the morbid process is very severe.⁷ Owing to the visceral arachnoid in many parts

¹ Am. Jour. of Med. Sci., vol. lxvi. p. 63. 1873.

² There will be found in Holmes's System of Surgery, 3d ed., vol. i. p. 620, a cut which shows the appearances described. See also Rokitsansky, op. cit.

³ Rokitsansky, op. cit., vol. iii. p. 342.

⁴ Hewett, op. cit., vol. i. p. 620; Watson, Practice of Physic, 4th ed., vol. i. pp. 377, 378.

⁵ Hewett, op. cit., vol. i. p. 621.

⁶ Many such cases would be called concussion by the majority of surgeons.

⁷ The intense cerebral congestion mentioned as having been found soon after concussion, readily explains the readiness with which the pia mater becomes inflamed after such accidents.

having a covering of endothelial cells upon the surface next to the brain, the relations of this membrane to its subjacent connective tissue differ from those of any other serous membrane, a difference which probably accounts for the peculiarities of limitation of inflammation just described.

Accumulations of perfectly clear, or slightly turbid serum, sometimes take place in the ventricles after head injuries. They generally coexist with inflammation of the membranes. Again, these effusions may take place slowly, when the head symptoms will be long delayed, and will probably concern the physician rather than the surgeon. When, however, the effusion takes place rapidly, with a scalp wound and bare bone, as in a case reported by Hewett, an error in diagnosis is very liable to occur, and the trephine may be resorted to with the expectation of evacuating pus between the dura mater and bone.

A middle-aged man received a scalp-wound by a fall in the street, which did not denude the bone. After prolonged collapse he reacted, and had most furious delirium, requiring restraint. The day before he had had, for the first time in his life, some kind of convulsive fit, but unattended with frothing at the mouth. The day following he complained of violent pain in the head, which persisted despite of treatment until the sixth day, when the scalp-wound became oedematous, and the bone denuded. Early in the morning of the seventh day the man suddenly began to hiccough, and became completely comatose, with normally acting pupils, a feeble, running pulse, and no stertor in respiration. A trephine was applied, after consultation, over the exposed bone, with the hope of evacuating matter from between the skull and dura mater; none was found, both the membrane and bone being healthy. The patient died unrelieved the same evening. Some serous effusion was found in the subarachnoid tissue, especially at the base of the brain, but the membranes were normal, and the pia mater was not congested. The ventricles were dilated, being filled with a large amount of serum, and the cerebral tissue was oedematous and softened. A small tubercular deposit was found in one of the cerebral convolutions of the base, but elsewhere none others were discovered, while all the organs of the trunk were normal.¹

This case bears out the advice which I have given with regard to trephining for intracranial suppuration; there were no pressure signs to warrant the belief that operation could afford relief.

Cerebritis.—As we have just seen, the cortical substance may be affected in inflammations which have reached the pia mater from whatever source. This form of cerebritis, however, is probably secondary to meningitis. In some cases of concussion, without laceration of the brain or ecchymosis into its substance, I have said that intense, general congestion may result. In such cases a cortical cerebritis supervenes, which we occasionally have an opportunity to investigate. I say occasionally, since simple concussion rarely produces a fatal inflammation. In the early stages of this form of cerebritis, the gray matter is swollen, soft, and of a dark-red color, and covered by a markedly congested pia mater, which, when stripped off, is apt to bring away softened portions of brain-tissue. At a later period, exudation takes place into the pia mater, and the dark cortical substance is so softened that it readily washes away under a gentle stream of water, leaving the white matter bare, much congested, but not softened. The extent of implication of the brain-cortex is variable, but it may even occupy a whole hemisphere, except the base, which in most cases is unaffected.

Brain-contusion and brain-laceration are the most common causes of traumatic cerebritis, and this can be detected should the patient survive for only a few hours. The first change noticed is a congestion of the brain, which impli-

¹ Hewett, op. cit., vol. i. p. 623.

cates its whole structure, but is most marked about the injured spot or spots. Next the cerebral tissue around the contusions assumes a darker hue, and becomes œdematous, swollen, and softened. Soon inflammatory effusions take place, which reduce the brain-substance to a variously tinted, soft, pulpy, or diffuent mass, readily washing away under a gentle stream of water. The portions of brain around the softened area are altered to a less extent, appearing disintegrated and shreddy. Although these changes are commonly limited to the neighborhood of the original injury, the greater part of an entire hemisphere sometimes becomes involved, when the white substance is apt to be of a "peculiar saffron-color" (Hewett) at the centre of intensity of the morbid process, the tissue being soft and diffuent.¹

A few drops or a gentle stream of water should be allowed to fall upon all suspected spots, as at times the marked disintegration undergone by the brain substance is not at first plainly perceptible. The yellow color is due to the large number of pus corpuscles and cells in a state of fatty degeneration, and possibly also to the remains of blood effused from the original injury, or more recently from the rupture of small vessels.

When the inflammation is limited, an abscess may result, proliferation of the surrounding neuroglia forming in some cases a thickened fibrous wall; under which circumstances the malady may remain quiescent for a long time.

A recent abscess consists of a rounded, irregularly-shaped cavity in the brain-substance, with walls formed of suppurating cerebral tissue, shreds of which, soaked in pus, hang into the cavity. The surrounding brain is in a state of inflammatory red softening, contiguous to which the cerebral substance is œdematous, while in many cases around the area of red inflammation is a zone of yellow softening. The contained pus is thick and greenish, and sometimes has an extremely offensive odor.² Cerebral abscess most commonly results from contusion and laceration of the brain-substance, but may arise from so-called simple concussion. Like collections of pus in other organs, it has a tendency to extend at its periphery, although it may burrow sinus-like in various directions. When it ruptures into one of the ventricles, death rapidly ensues. Various cases have been reported in which the pus from cerebral abscesses has found its way, by ulceration through the bones, into the nasal fossæ or ear, recovery having ensued. The amount of pus and the suddenness of its discharge have been the arguments chiefly relied upon to prove the cerebral origin of these abscesses, when recovery has taken place. I have no doubt myself that some of these have been really cases of circumscribed intrameningeal accumulation, although in a few, post-mortem examination has demonstrated their cerebral origin.

Symptoms of Intra-cranial Inflammation.—The symptoms of intracranial inflammation will be first considered as a whole, and then an endeavor will be made to point out those special symptoms which may be of use in determining which of the various intracranial structures is chiefly diseased. My reason for treating the subject in this manner, is that I do not believe it to be possible to determine positively whether in one case the membranes alone are inflamed, or whether in another the brain is solely involved.

The first symptom commonly noticed is headache, which may be either slight or severe, may be confined to the seat of the blow, or may extend from that point over the whole head. Dizziness, vertigo, tinnitus aurium, flushed face and suffused eyes, coated tongue, and anorexia are commonly observed. The pupils are contracted and abnormally sensitive to light, and there is in-

¹ This is the yellow softening already referred to on page 70.

² Rokitansky, op. cit., p. 413.

tolerance of sound. Fever, with hot, dry skin, and a rapid, hard pulse, accompany these cerebral symptoms. All the symptoms increase in severity with the advance of the intracranial inflammation, and soon nausea, vomiting, obstinate constipation, restlessness, constant jactitation, delirium, and convulsions—one or all—mark the progress of the case. Then, as the inflammatory effusions are poured out, symptoms of irritation or pressure begin to manifest themselves. Drowsiness, dilatation of one or both pupils, oscillation of the eyeballs, irregular twitchings or even spasms of the muscles, steadily increasing coma, stertorous, puffing respiration, a slow, full pulse, incontinence of feces and urine—the result of paresis of the sphincters—paralysis, and death, too commonly succeed one another. Where the pressure-symptoms are due to the formation of pus, more or less marked chilliness, or rigors, are apt to precede the signs of compression. If cerebral abscess forms, the temperature will be usually subnormal, either at the outset only, or continuously until the pus is evacuated, when it will probably suddenly rise.

While typical cases present most, if not all, of the symptoms detailed, and commonly in the order given, in many instances they vary markedly. So dissimilar from the standard given in text-books are many cases met with in practice, that the diagnosis of intracranial inflammation is oftentimes a most puzzling affair to the tyro, and may sometimes even baffle the expert. Although it may be impossible positively to assert, in any case of head-injury, that the symptoms proceed from an inflammation of the brain-substance and the visceral layers of the meninges, the result of concussion—or that they are due to contusion and subsequent inflammation of the bone and the subjacent dura mater, with the parietal arachnoid—yet attentive study of the time of onset of cerebral symptoms often enables the surgeon to determine where the inflammation has started, and therefore the structures which are most likely to be chiefly involved. A post-mortem examination will, indeed, often disprove the opinion thus formed, but in many cases it will verify the accuracy of the inferences founded upon the time of onset of the symptoms.

From the intense congestion of the cerebral mass, with its investing pia mater, which results from *concussion*, we should expect the early onset of signs of inflammatory mischief; and accordingly we find that in many cases the symptoms begin within a few hours.

Four or five days usually elapse before symptoms of cerebritis declare themselves after *contusion* or *laceration* of the brain-substance, and until this time a most deceptive calm, with an apparent entire absence of any mischief resulting from the injury, is apt to prevail.

Inflammation consequent upon *contusion of bone* may appear early, as in a number of Pott's cases, but it is far more apt to "smoulder," as has been said, for two or three weeks, and then to suddenly burst forth.

The symptoms of *cerebral abscess* are not usually pronounced until about the twenty-fifth day upon the average, although I have seen them within two weeks of the injury.

Convulsions are a most uncertain symptom, especially in the young. When occurring immediately after the injury, they are certainly not due to inflammation. Again, they may appear just about the time when intracranial inflammation is to be expected, leading to the supposition that encephalitis has commenced, when nothing of the sort exists. Being simply indicative of irritation of the cerebrum, of its membranes, or of all these structures, convulsions are produced by too many varied causes to be of any particular value as a means of diagnosis in intracranial inflammations.

Treatment.—I place in the first rank as to importance, prophylaxis. As has been, I trust, made clear, there is a variety of meningitis arising directly from the intense congestion of the brain and its membranes which results

from concussion, even without any cerebral contusion, and this inflammation sets in very early, sometimes even within a few hours. I am, therefore, in the habit, in cases of concussion, unless the patient has lost much blood, or is from any cause peculiarly feeble, of directing that the strictest antiphlogistic regimen shall be pursued for the first forty-eight hours, that is to say, that nothing but water shall be allowed. Dry cold should be applied to the head, which should be shaved if the case be a bad one. The room must be darkened and the head kept slightly elevated. A calomel purge, followed by a saline, should be at once administered. After the first forty-eight hours, or from the outset if the patient be feeble or have lost much blood, a milk diet must be substituted for the starvation plan, lest suppuration should be favored by depression of the bodily powers. I prefer, however, that the smallest quantity of milk compatible with supporting the patient's strength should be indulged in until after the fifth or sixth day, that is, until after the usual time of onset of intracranial inflammation. I know that with many this system of treatment is out of vogue, but when judiciously resorted to, I am satisfied that it is the safest course to pursue, and on this plan I have treated a number of severe head-injuries without anything indicating that I had better have resorted to other measures. Upon the other hand, an increase of diet has been followed over and over again by vertigo, increased headache, and fever, all of which symptoms have spontaneously subsided upon returning to a more meagre allowance.

At the first onset of pronounced cerebral inflammation, in very vigorous patients, venesection may be resorted to in just sufficient quantity to sensibly affect the pulse. I prefer, however, to rely upon wet-cupping or leeching, without venesection, and, should the latter have been resorted to at first, wet cups to the nape of the neck should be used if occasion arise for the further abstraction of blood. I am persuaded that free cupping cannot fail to be of decided benefit in many of the cases which are received into our large hospitals. The system should be as rapidly as possible gotten under the influence of mercury, and to this end one-fourth of a grain of the mild chloride, combined with an equal amount of opium,¹ should be exhibited every two hours. Should the system prove rebellious, mercurial inunctions may be used as adjuvants. When the abstraction of blood is thought inadmissible at the outset, or when no longer considered advisable, free and frequent purgings are indicated, always remembering that the patient under treatment is to be considered, not as a supposititious "case" of encephalitis for which such and such remedies have been recommended, but as a person whose condition varies from day to day, nay, from hour to hour.

Intermittent compression of the carotids has been recommended by Neudörfer, Vanzetti, and others, and where practicable it might be tried, as it should theoretically prove beneficial.

Sleeplessness, or the furious delirium which occasionally supervenes within the first few days after a head-injury, must be relieved by the cautious use of opium. I cannot enter into theoretical reasons why opium is not harmful in head-injuries, as is so often contended. I only know that I do not hesitate to use it when it appears indicated, and that so far, in common with the most experienced surgeons, I have seen nothing but good result from its employment. By quieting the heart's action, less blood is sent to the brain, the mind is set at rest during sleep, and nervous fret and worry are relieved. Opium in some way unquestionably causes contraction of the peripheral capillaries; why should it not then similarly affect those of the brain? When the

¹ If this amount of opium should produce too much drowsiness, or stupor, especially in the case of children, it must, of course, be diminished.

heart's action is strong and frequent, aconite and veratrum viride may be found useful, either with or without the opium. Chloral and the bromides, as supplementary to opium, or to replace it, will prove useful in cases of excessive wakefulness, and where there is a marked tendency to convulsions.

The condition of the kidneys as to prior renal disease should be investigated, as otherwise we may confound cerebral symptoms of renal origin with those due to traumatism.

What testimony does experience give as to the results of antiphlogistic treatment? In our late war, where it was not considered essential, Otis states that four-fifths of the cases of injury to the skull and its contents proved fatal, while the British surgeons in the Crimean War, and the German surgeons in 1849-50, saved more than one-half. To be sure, the more universal adoption of rifled weapons may make this difference in reality less than it seems, but it cannot account for the entire discrepancy.

Should blisters or other forms of counter-irritation be used? I think not, and certainly only late in the disease.

Suppose that the case does well, when must the antiphlogistic measures be exchanged for a more ordinary diet and treatment? This must be left to the surgeon's judgment in each special case. I know nothing much harder to decide than, at the bedside of a patient with serious head-injury, to correctly indicate when a resort to a more liberal diet should be initiated. Of course, when the patient is manifestly becoming rapidly exhausted, the question is simple enough. It is in those cases which are doing well, with apparently not much amiss with them, that errors arise. No sudden change should be allowed, but a more generous dietary may be tentatively instituted. Stimulants even are required in some cases, but here I prefer digitalis, to improve the power of the heart, or ammonia in some form, rather than alcohol.

Having gotten the system under the mercurial influence, the calomel must be omitted, or given at longer intervals. In the later stages, iodide of potassium and ergot have proved serviceable in my hands.

In the later and more insidious forms of traumatic encephalitis, to which the terms subacute or chronic may be applied, where the patient, after some slight injury, persists in attending to work and business, until slight headache, mental irritability, constipation, broken sleep, vertigo, and fever set in, to be followed by delirium, etc., the treatment does not materially differ from that already indicated, except that depletion is less well borne, and that mercurial purgatives and a more generous diet seem rather indicated than a strict antiphlogistic regimen.

After any attack of intracranial inflammation, the patient must regard himself as an invalid for a long period, entirely abstaining from work or only gradually returning to it, and at once relinquishing it upon the slightest sign of cerebral irritability.

CEREBRAL ABSCESS.—So grave does any operation for intracranial abscess appear to the public, that many surgeons allow themselves to be influenced by the fear of blame should death result, and are too apt to confound the great fatality inherent in the disease itself, with that of the operation destined for its relief. A calm consideration of the natural history of the affection in question, will, I believe, show that, when accessible, these depots of pus should be treated upon the same principles that govern us in dealing with circumscribed suppurations elsewhere. Are such collections of pus, even in the arachnoid cavity, ever absorbed? There is no such case on record. What do autopsies teach us with regard to abscesses of the cerebral substance? That in the vast majority of cases they enlarge, by involving more and more

of the brain at their periphery,¹ until they either by pressure² induce fatal trouble, or by bursting into the ventricles rapidly destroy life.³ In some few cases the surrounding proliferating neuroglia is finally organized into a firm sac-wall, and the disease remains stationary for a time, but only stationary—not cured.⁴ In a few of these cases, post-mortem appearances would seem to indicate that caseation of the contents of a former brain-abscess had taken place, and that recovery by partial or complete absorption was therefore possible. Such an occurrence must be exceedingly rare, and I doubt if it ever takes place in traumatic cases, where the surrounding cerebral substance, instead of being condensed, is more apt to be softened. Sooner or later, such quiescent abscesses will terminate life, and that, too, very suddenly in most cases. A still further study of the natural history of cerebral abscess will give us, I think, some valuable therapeutic hints. Among the greatest of surgical rarities is the spontaneous evacuation of a cerebral abscess, either through the nares, orbit, or external auditory meatus.⁵ This can only take place when the suppurating cavity lies near such portions of the skull as the cribriform plate of the ethmoid, the roof of the orbit, or the tegmen tympani. Such was the case in a patient who was under the care of Mr. C. Hawkins, and an abstract of whose history I here subjoin:—

A man twenty-eight years of age, three weeks before his admission into hospital, struck his head violently against the edge of a door, producing a small wound on the right side of the forehead, with much ecchymosis, with but little external hemorrhage. There was intense pain at the seat of the blow. A week afterwards, headache and delirium came on. A discharge from the left ear of many years' duration, which had before stopped running from time to time, when marked deafness was always noticed, now ceased. The pulse was frequent and weak, but there was no more pain upon the left side of the head than upon the right side. Two days subsequently the pulse was "laboring" (I presume slow and full). The patient became comatose, and died the next day. After death, an abscess with softened, ragged walls was found in the left anterior and middle lobes of the cerebrum, containing about three ounces of pus. The dura mater was adherent to the roof of the tympanum, and through the necrosed bone a small probe could be passed into the middle ear, which showed evidences of chronic otitis with destruction of the membrana tympani.⁶

This abscess was clearly secondary to the old otitis, and the blow probably set up active disease in the adherent and diseased dura mater overlying the chronically inflamed middle ear. Other similar cases, where recovery has ensued, might be quoted if it were necessary, to demonstrate that nature can and does successfully evacuate cerebral abscesses.⁷ The next link in my chain of argument is, that after an unsuccessful attempt had been made to discover pus in certain cases, and when the trephine had revealed a healthy, non-bulging, pulsatile condition of the dura mater, this membrane was nevertheless

¹ By a rapidly progressing yellow softening in many instances.

² Acute oedema of the brain is frequently the immediate cause of death. Chronic internal hydrocephalus is common in cerebellar abscess, whenever it tends to lessen the cavity of the fourth ventricle, or to compress the aqueduct of Sylvius. (See Ziemssen's *Cyclopædia of Practical Medicine*, vol. xii.)

³ Abscesses situated in the middle of the parietal and frontal lobes open usually into the ventricles. Those of the middle lobe may open at the base of the brain, giving rise to a most fatal form of meningitis.

⁴ Meyer (Ziemssen's *Cyclopædia of Practical Medicine*, vol. xii.) has shown that, although as reported by Lallemand, a capsuled brain-abscess may be met with as early as the thirteenth day, a distinct abscess-wall is upon the average not seen before seven weeks.

⁵ Perforation through the orbit, the temporal bone, and other portions of the skull-bones, after agglutination of the membranes, has been reported. If adhesions do not form, a widespread fatal meningitis is apt to occur when nature strives to spontaneously evacuate these abscesses.

⁶ London Medical Gazette, First series, vol. xvii. p. 156.

⁷ Tassi, Proceedings of the Royal Academy of Medicine of Rome, quoted in the *Lancet*, April 26, 1884; Hawkins, loc. cit., p. 162.

incised, and in a few hours or days nature ruptured the superjacent brain-substance, and, the pus having escaped externally, recovery ensued. Here, as elsewhere, a brief account of a few selected cases will convey my idea better than a mere general description:—

A child nine years old, suffering from a compound depressed fracture of the frontal bone, was trephined by Petit. Headache and fever set in on the night of the fifth day, and on the following day the dura mater, distended and discolored, bulged into the opening. A tablespoonful of brown, fetid fluid was evacuated by incision of the dura mater, but the symptoms steadily increased up to the night of the eleventh day, when rapid improvement occurred, and it was found that a large abscess had burst and saturated the dressings with offensive matter. Complete recovery ensued in two months.¹

Dr. Joseph Pancoast trephined in a case where the altered dura mater puffed up through the trephine-opening. Incising this, allowed the softened brain-substance to pout through the wound. Urgent symptoms being absent, although a sensation of distinct fluctuation was felt, nothing further was done. The abscess opened spontaneously next day, and the patient improved for two weeks, more or less pus being constantly discharged. On the sixteenth day, owing to obstruction to the flow of pus—as was proved by an autopsy—death resulted. The abscess communicated with the posterior horn of the opposite ventricle.²

Acquaintance with these facts logically leads us a step further, and, an abscess of the brain-substance having been diagnosticated, an incision would seem indicated to evacuate the matter, just as it would be in a case of subcutaneous phlegmon. Examination of the records of our art shows that this practice has been repeatedly adopted. Thus among others I find the following apposite cases:—

An officer was struck by a pistol-ball, which grooved the outer table of the left frontal bone. Marked symptoms of encephalitis set in on the tenth day, but subsided under treatment. In consequence of excesses of diet, intense headache, rigors, etc., declared themselves upon the twenty-third day, followed in seventy-two hours by convulsions, aphasia, right hemiplegia, and coma. Upon the twenty-ninth day after injury, Surgeon J. F. Weeds trephined over the left frontal eminence, and found a small scale of the inner table lying loose upon the slightly lacerated dura mater. An incision was made into the substance of the brain, evacuating half an ounce of green, offensive pus, when the symptoms of compression disappeared in ten hours, and recovery ensued.³

Dupuytren had a patient who had been wounded by a knife-blade on the top of the head. The weapon broke off short in the bone, and the fragment was overlooked by the surgeon who first dressed the wound. This healed, and no trouble, save occasional pains about the scar, followed for over two years, when the man suddenly became unconscious, and in that condition was admitted into the Hôtel-Dieu. Examination of the old scar and subsequent incision revealed the point of the knife imbedded in the bone. He was trephined without relief, and opposite hemiplegia made its appearance. Incision of the dura mater revealing nothing, Dupuytren plunged his knife deeply into the brain, whereby a large quantity of pus was evacuated; the symptoms disappeared, and the patient ultimately recovered.⁴

Upon the other hand, an equally favorable opportunity for surgical interference presented itself to De la Peyronie, but was lost; and with it the patient's life, by the declination of further operative interference after the dura mater had been incised without discovering pus. In this case, the autopsy revealed an abscess immediately below the trephine-opening, only three or four lines beneath the surface.⁵

¹ J. L. Petit, op. cit., p. 354.

² Treatise on Operative Surgery, 2d ed., p. 106.

³ Nashville Journal of Medicine and Surgery, April, 1872.

⁴ Leçons Orales, 2e éd., tome vi. p. 146.

⁵ Mémoires de l'Académie Royale de Chirurgie, tome i. p. 319. Paris, 1743.

Finally, let me illustrate by my own practice and that of others, what I believe to be the proper treatment in cerebral abscess:—

On the morning of March 6, 1884, J. Y., aged nineteen years, walked into the Episcopal Hospital, complaining of a sore on the top of his head. He said that it was the result of a blow which he had received two months previously at Chicago. On examining the wound, an ulcer was found located about the position of the left middle parietal lobe. In the centre of this ulcer was the broken edge of a knife-blade. Upon being told of this, he seemed thoroughly surprised that such was the case. But little could be made out by closely questioning him as regarded the incidents of the attack, except that a man had struck him on the top of the head so forcibly that he had fallen on his hands and knees, but had recovered himself almost immediately. He said that he did not at that time, nor afterwards, lose consciousness, nor had he had even a headache. All symptoms of brain-injury were absent. He did not complain of any pain or uncomfortable sensation when the knife-blade was removed by the gentleman who first saw him; but in the afternoon of the same day he had slight pain in the head. His appetite was good, and his bowels constipated. March 7, patient had rested well through the night; did not complain of headache. Temp. 100° F.; pulse 80.

An examination of the eyes was made by Dr. Heyl, five hours after the withdrawal of the knife-blade, with the following result:—

Pupils reacted normally to incident light. Media and optic papilla normal. Retinal arteries of full size in the left eye, probably also in the right eye. It was difficult to pronounce positively on this point, owing to the peculiar distribution of the vessels. Veins in both retinae enlarged and of a black color. Arteries and veins in each eye tortuous. Very many fine, thread-like reflections of light, doubtless from very fine vessels. Diagnosis was retinal hyperæmia, arising from intracranial circulatory disturbance.

March 8, temp. 100° F.; pulse 80. This afternoon, at one P. M., after the wound had been examined, he was seized with an epileptiform convulsion which lasted about two minutes; no particular movements were made which could lead to the localization of the source of irritation. At four P. M. he had another attack, but not as severe as the first, being conscious during the paroxysm. At ten P. M. a very violent convulsion occurred, the patient remaining unconscious five minutes. The attack began with a twitching of the right arm, but soon became general. Having been sent for, I trephined the skull over the seat of injury, removing a button of bone which showed a slight depression of the inner table. The position which the blade had occupied could be seen in the dura mater, there being an opening surrounded with dense cicatricial tissue. The dura mater did not seem to be congested, and there was evidently no pus or fluid beneath it. The wound was washed out with a solution of corrosive sublimate, one part to two thousand, and then dressed with sublimated gauze.

March 9, temp. 100° F.; pulse 83. The patient seemed easy this morning, except for slight pain about the wound. At 11 A. M. he was seized with a muscular tremor of the lower extremities. He was conscious during the attack, but could not control the movements, which lasted about three minutes.

March 10, temp. 100° F.; pulse 80. Doing well this morning, no headache.

March 14, temp. 98° F.; pulse 62. The wound is looking well; moderate, healthy suppuration. Patient's general condition is worse. Marked hebetude and slow pulse. He sleeps the greater part of the time. Brain-abscess suspected.

March 17, temp. 102° F.; pulse 67. This morning an erysipelatous blush is noticed over the forehead, but not about the wound. The attack lasted until the 21st, being limited to the face and yielding easily to treatment.

March 22, temp. $98\frac{1}{2}^{\circ}$ F.; pulse 76. Patient's condition is still worse. The tongue is coated, dry, and fissured. Pulse slower, and memory failing.

March 25, morning and evening temp. 98° F.; pulse 60.

March 26, temp. $97\frac{1}{2}^{\circ}$ F.; pulse 53.

March 27, morning temp. $97\frac{1}{2}^{\circ}$ F.; evening temp. $98\frac{1}{2}^{\circ}$ F.; pulse 70.

March 29, the patient's condition is about the same; incontinence of urine; hebetude more marked. Pulse 52; morning temperature 99° F.

March 30, temperature 99° F.; pulse 70. This morning I found the patient unconscious, and with right-sided hemiplegia; he was rapidly sinking.

The symptoms of brain-pressure being so marked, immediately upon my arrival I reflected the flap covering the trephine-hole, and found it filled by the tensely stretched dura mater, which, however, pulsated strongly at every portion. A feeling as of fluctuation was conveyed to the finger. While examining the wound, a minute drop of pus, not larger than a small pin-head, oozed up through the dura mater. Supposing that the cause of the trouble was reached, I made a small incision through that membrane, but, to my disappointment, nothing was evacuated. Further manipulation brought about half a minim of pus, which was thought to come, perhaps, from a diffused layer of pus in the arachnoid cavity. The coma rapidly deepening, an aspirator-needle connected with a vacuum was passed in at least three, if not four different spots, to the depth of two-thirds of an inch, but with no result. Feeling convinced that pus was present, and that from the symptoms it was compressing the ascending frontal and parietal convolutions, I proceeded to set a large crowned-trephine in front of, and below the first opening, which was slightly behind the fissure of Rolando, according to my calculations. Before I had more than half divided the skull, both pulse and respiration ceased, and the patient was thought to be dead, by both my colleague Dr. Morris J. Lewis, the three resident physicians, and myself. After laying the instruments aside for a moment, I determined to complete the operation. Rapidly dividing the bone, I found an apparently normal dura mater, which I incised, but found nothing. While Dr. Lewis and I were examining the exposed membrane, a large drop of pus oozed up through one of the aspirator-punctures. I at once plunged a knife into the brain-substance, and evacuated from one to two fluidounces of greenish pus. The patient appeared to be quite dead, but placing my hand over his heart I thought, but was not sure, that I felt a feeble cardiac pulsation. Dr. Lewis immediately seized the patient's arms and began to practise artificial respiration. In about half a minute his skilful efforts were rewarded by a gasp, and then the diaphragm feebly contracted. I then sent for the battery, which was effectively used by Dr. J. K. Mitchell; one-hundredth of a grain of atropia was subcutaneously injected; sinapisms were applied over the heart; a turpentine enema was administered; warmth was applied to the feet, etc. After some twenty minutes' vigorous treatment, the intercostal muscles commenced to act slightly, but, on the cessation of efforts at artificial respiration, in a few moments the patient ceased to breathe. Renewed efforts resuscitated him. In two hours' time he was semi-conscious, and could feebly move his right arm. All pulse and respiration had ceased, at the lowest computation, for fully three minutes.

March 31, temp. $97\frac{1}{2}^{\circ}$ F.; pulse 120. Patient much better, and conscious. An ophthalmoscopic examination was made to-day by Dr. Heyl. Left pupil a little sluggish in its reaction to light. Right pupil normal. Margin of each papilla absent. Retinal veins of large calibre, tortuous, and filled with very black blood. Arteries, if of abnormal calibre, are slightly diminished in size on the retina, but of normal calibre on the disks. The optic disks do not look swollen, as is commonly the case in papillitis, but as if they possessed the same level as adjoining parts of the retina. The refraction of the papilla and surrounding parts of the retina were not obtained. It is also noted that at the time of examination the patient's face is dusky, but that his mind seems clear. The diagnosis is double papillitis in the stage of retrogression. A hernia cerebri the size of a walnut is extruding from the wound in the dura. The abscess discharges freely. The patient does not complain of headache.

April 1, temp. 102° F.; pulse 110. Erysipelas again on forehead, extending over face. The hernia cerebri is now about the size of an egg. Patient is losing strength.

April 2, temp. 103° F.; pulse 112. Condition worse, hernia breaking down and coming away with poultices.

April 4. The patient died this morning at 6.30 A. M. He remained conscious until three hours before his death.

Autopsy.—About the position of injury, the dura mater was bound down to the brain by inflammatory adhesions. The left parietal lobe was an enormous abscess-cavity. The abscess was superficial, destroying the greater portion of the upper part of the left hemisphere. The right hemisphere moist; the dura congested. Old pleuritic adhesions were found in the chest; the lungs were affected with hypostatic congestion, but otherwise normal.

Mr. Hulke reports the following cases:—

A boy aged 13, whose forehead had been grazed by a push against an iron fence, was trephined by me seven weeks after the accident, incomplete hemiplegia having supervened. The graze had festered, healed slowly, and left a tender scar. From the time of the injury there had been more or less severe headache; and latterly nausea and retching. The pulse was unnaturally slow and the temperature subnormal. The trephine was put on at the site of the injury on the right of the middle line of the forehead. The outer table was found slightly starred, but the cracks did not reach the inner surface of the bone. The dura mater, which appeared to be healthy, bulged up tensely into the bone-hole. An aspirator-trocar, connected with an exhausted syringe, was pushed through it, and when this had reached the depth of about one inch, greenish pus was drawn up. The abscess was then freely opened with a narrow scalpel, and a quantity of pus, estimated at from three to four fluidounces, escaped. The hemiplegia soon disappeared; the other symptoms less quickly. Optic neuritis supervened and ended in blindness. Several months afterwards, whilst in the blind school, the patient had epileptiform fits. He was kept in view during several years, and, when last seen, was a very intelligent, well grown youth.¹

A laborer, aged about 60 years, was recently admitted into the Middlesex Hospital, under my care, a fortnight after being struck a glancing blow on the right temple by a falling ladder, which stunned him for a few minutes and caused a considerable bruise. He continued, nevertheless, to work as usual until the middle of the third day, when the headache which he had had from the time of the accident became very severe—so severe that his wife feared he would go out of his mind.

When taken into hospital he described the pain as darting from the seat of the blow (marked by a slight discoloration) through his head. The pulse was 56, and the temperature slightly below the normal average. His mind was unclouded. About one week afterwards, he became insensible in the night, and in the morning the right upper and lower limbs were found absolutely palsied as regarded motion, and nearly so as regarded sensation. When the right arm or thigh was severely pinched, he gave scarcely any sign of consciousness of it, but shrank slightly when the left arm or leg was pinched similarly. Two days subsequently, spastic rigidity of the left arm supervened. His wife, who had till now obstinately refused any surgical interference, permitted trephining. A small disk of bone beneath the bruised spot in the right temple was cut out. It appeared uninjured and healthy. The dura mater bulged up so tensely into the bone-hole that pulsation could neither be seen nor felt. The exposed surface of the membrane appeared healthy. An aspirator-needle, connected with an exhausting syringe, was pushed through it to a depth of about one and a quarter inches. A brownish, turbid fluid rose up into the receiver, and continued to flow through the prick-hole after the needle was withdrawn.

The minute opening was enlarged with the scalpel, and a considerable quantity of fluid escaped. The flaps which had been reflected were replaced, and the wound was very lightly dressed with a little boric charpie. An hour afterwards he asked for food. Next morning the spastic rigidity of the left arm had gone. On the second day slight return of power was noticed in the right limbs, and before the end of a week their palsy had disappeared. For a very few days after the operation, the charpie was wetted and discolored by the fluid which continued to ooze; but this oozing soon ceased, the wound soon healed, and two months from the date of the operation the patient appeared quite well.²

In some cases, even less operative interference may be necessary, owing to the sloughy condition of the dura mater and of the superjacent brain-substance. Thus Mr. Hulke gives the following account of a case under his charge:—

A middle-aged woman, having fallen down in a fit in a neighboring street, was brought to the Middlesex Hospital. She was unconscious, and her left arm and leg were rigidly flexed. On the right temple was a small festering wound, leading to

¹ *Medico-Chirurg. Trans.*, vol. lxii. p. 367.

² *Holmes's System of Surgery*, 3d ed., vol i. p. 628.

necrosed bone. On perforating this with a trephine, several drachms of pus were forcibly ejected through a sloughy hole in the dura mater. The spastic rigidity of the left arm and leg immediately disappeared, but the patient soon died. At the examination of her body the empty cavity of a large abscess was found in the anterior lobe of the right cerebral hemisphere.¹

Diagnosis of Cerebral Abscess.—As to diagnosis, I can only refer to the histories of the last cases which I have given. Mental hebetude, slow pulse, headache, perhaps rigors, subnormal temperature, constipation, and at the end sudden development of the symptoms of compression, as evidenced by profound coma, hemiplegia, respiratory failure, and death, seem to have, in all cases, marked the course of the brain-abscess.

I believe that an abscess involving the cerebral tissue alone, will be accompanied in most cases by a subnormal, or at least not an elevated temperature.² Where a high temperature is observed, either the pus-collection is simply a localized suppurative arachnitis, limited by adhesions, or there is a meningitis in addition to the abscess. If originating from bone-caries, middle-ear disease, etc., where the abscess is secondary, there is almost of necessity an elevated temperature, although even here, during the height of the symptoms, as in the last six days of life in a case reported by Huguenin,³ the temperature may be normal.

If these observations are confirmed by others, a valuable diagnostic point will be afforded.

Can cerebral localization aid us in our diagnosis? I think that in cases where, after head injury, the patient presents the train of symptoms just detailed, with distinct implication of one or all portions of the motor area of one side, when death is imminent, even without external wound trephining and the use of the aspirator are at least warranted, if not demanded, in view of the success which has been obtained by their employment. If the motor area is not involved, or has not been primarily affected or injured, nothing beyond the purest chance could lead to a successful operation, with no bone-injury as a guide.⁴

Prognosis.—I do not presume to say that great success will attend operations for brain-abscess, but experience warrants the statement that every recorded recovery has been due to operation.

As in the great majority of cases, it is impossible at the time of operation to determine whether the abscess is located solely in the cerebral tissue, whether there is simply a localized collection of pus in the arachnoid sac, or whether the abscess-cavity consists partly of cerebral tissue and partly of the membranes, I shall quote the results of thirty cases, which will give an approximate idea of the chances of recovery in these affections. These cases have been reported by De la Peyronie, Dupuytren, Guthrie, Dumville, Noyes, Detmold, Ashhurst, Clark, Weeds, Holden, Hulke, Maunder, Tillaux, Lloyd, Chinault, Courvoisier, Stimson, Morehouse, Bontecou, Peek, Jalland, Elean, Broca, Polaillon, Kilgariff, Edmunds, Milford, W. D. Roberts, and myself. Of this number just one-half proved fatal. Of course I do not mean to say that fifty per cent. represents the actual mortality, but, as far as this series of cases goes, the results are encouraging.

¹ Holmes's System of Surgery, 3d ed., vol. i. p. 626.

² See p. 27 of this article for a third case by Mr. Hulke, where the temperature was subnormal, making, with the following, five cases which I have noted as presenting this symptom. M. L. Brown reports a case of brain-abscess after fracture of the ethmoid bone, where the temperature was subnormal—97° F.—for eleven days. (Bost. Med. and Surg. Journ., Dec. 29, 1881, p. 610.)

³ Ziemssen's Cyclopædia of Practical Medicine, vol. xii., page 735.

⁴ See a case on p. 76 of this article, which I consider was eminently unfitted for operation, as perusal of its history will make clear.

Chronic Cerebral Abscess.—Although death after acute encephalitis may take place in the period of red softening and suppuration, consequent upon traumatism of the brain, nearly all the cerebral symptoms may disappear, even while a chronic abscess is forming. During this latent period (which usually varies from one to two months, although it may be of only a few days' duration), when portions of the brain possessing definite functions are affected, symptoms of localized disease may be noticed, such as aphasia, paresis, or hemiplegia, and even convulsions, which are commonly general, but are more rarely limited to certain groups of muscles. Strabismus is very rare. Signs of constant, slight pressure upon the brain may sometimes be detected, such as more or less continuous headache, accompanied during the exacerbations by occasional slight fever, dizziness, and nausea. Violent headache probably means tension of the abscess, and congestion around it. The more frequent these attacks of severe cephalalgia, the more probable is it that acute red-inflammatory softening, yellow softening, and extensive cerebral œdema, are imminent; in other words, that death may take place at any moment. Occasionally dulness of the senses, slowness and want of motor energy, and gradual imbecility, accompany the chronic headache. Sleeplessness, optical delusions, and intermittent attacks of extreme terror have also been recorded. Again, after a rapidly developed, severe headache, the patient may become comatose and feverish, these symptoms lasting only for a few hours. Chills have been very rarely noted, but have been sometimes so marked as to give rise to the erroneous diagnosis of intermittent fever. Epileptiform convulsions often occur during the latent stage of chronic brain-abscess, but are in no way peculiar or diagnostic. The terminal processes of chronic cerebral abscess are, perforation outwards, with meningitis of the convexity of the brain; perforation at the base, with basal meningitis; rupture into the ventricles, extensive cerebral œdema, pressure upon the medulla oblongata by a cerebellar abscess, and remarkable anæmia of the brain. The symptoms attendant upon the last stages of brain-abscess are often those of mental irritation, restlessness, illusions, and violent delirium, with elevated temperature; but they are of such brief duration as to be frequently overlooked, and are followed by sopor, severe headache, slow pulse, dilated and feebly-acting pupils, depressed temperature, passive retinal congestion, occasional vomiting, complete coma, and involuntary evacuations. Hemiplegia—or more rarely other forms of paralysis—respiratory failure, and death usually result. Convulsions sometimes occur. Muscular contractures are at times noted. When perforation induces meningitis, a corresponding change and confusion of symptoms result, which I need not here attempt to describe. Cerebral localization may aid us in locating these abscesses, provided that they occupy certain positions. They—even more than acute abscesses—give rise to errors because of secondary involvement or irritation of contiguous or closely associated portions of the encephalon, whence errors can so readily arise that the greatest caution must be exercised in making up our final opinion.

I would refer the reader to Huguenin's excellent article on this subject in Ziemssen's *Cyclopædia of Practical Medicine*, for the differential diagnosis of chronic cerebral abscess, as my limits do not admit of my saying more than that intraocular ophthalmoscopic appearances and eye-symptoms are here unreliable, and that brain-tumor is the disease with which this affection is most apt to be confounded.

CEREBRAL LOCALIZATION.

Whatever may be urged by the opponents of cerebral localization, I think that there will be few who will deny that the situation of the cortical motor area of the brain is now definitely known, and that by the aid of certain measurements we can locate, with sufficient accuracy for operative purposes, the fissure of Rolando, and, in consequence, the ascending parietal, frontal, and other convolutions. The latest authoritative expression of opinion is to the effect that, "there does not yet exist a single accurate observation of a destructive lesion outside the motor area, having produced permanent paralysis, nor does there exist a single accurate observation of a destructive lesion of any extent of the ascending convolutions, which has not given rise to permanent paralysis of the opposite side of the body."¹ Owing to the commissural connections of the various portions of the brain, to the surrounding areas of softening, or to the œdema which accompanies inflammatory lesions, secondary phenomena attendant upon brain-injuries apparently contradict these statements, but primary circumscribed lesions produce symptoms which are neither uncertain nor misleading. For surgical purposes, it must never be lost sight of, that in proportion as the symptoms indicate circumscription of the lesion, so is their value; and that evident implication of many centres, and inconstant symptoms, should make the surgeon review his diagnosis, so that no unnecessary or useless operation may be performed.

There are already on record at least five cases in which success, as regards the discovery of the lesions, has attended an operation guided by cerebral localization, and in three of these cases the patients have recovered or been relieved.

Let no one think that I am contending that cerebral localization can be frequently available for surgical purposes as indicating an operation. This must be comparatively rare, although I believe that confidence resulting from more extended experience will in the future lead to more frequent interference. The chief advantage to be gained at present from our improved knowledge of cerebral topography, is that it will direct in many cases when to withhold operative interference, as has been pointed out under the head of intracranial extravasations of blood.

For surgical purposes, we may consider that the various cerebral centres are located as taught by Lucas-Championnière:—

Lower extremity, summit of the ascending parietal convolution. *Upper and lower extremity*, summit of the ascending frontal and parietal convolutions. *Upper extremity*, middle portion of the ascending frontal convolution. *Upper extremity and aphasia*, inferior third of the ascending frontal, and foot of the third convolution. *Facial paralysis*, inferior third of the ascending frontal, and foot of the second frontal. *Aphasia*, foot of the third frontal. These differ slightly from Ferrier's points, but less so than would appear at first sight, and I am disposed to agree with Lucas-Championnière, that, surgically, they are more practically useful.

NATURE AND FORMS OF THE PALSIES AND CONVULSIONS OBSERVED IN WOUNDS OF THE HEAD.—These palsies result from superficial lesions of those portions of the brain which lie almost without exception beneath the anterior half of the parietal bone (see Fig. 1090), and they correspond closely to those experimentally produced upon animals.

As traumatic cerebral lesions are almost never limited to a point, but com-

¹ Charcot, *Revue de Médecine*; *Med. Times and Gazette*, 1883, vol. i. p. 616, and vol. ii. p. 491; *Ibid.*, 1884, vol. i. p. 270.

prehend a certain extent of brain-tissue, neighboring centres to those chiefly injured will give rise to symptoms confusing the diagnosis. The paralysis is opposite to the side of lesion. The following combinations are those usually met with: Paralysis of face and aphasia. Aphasia and palsy of the

Fig. 1090.

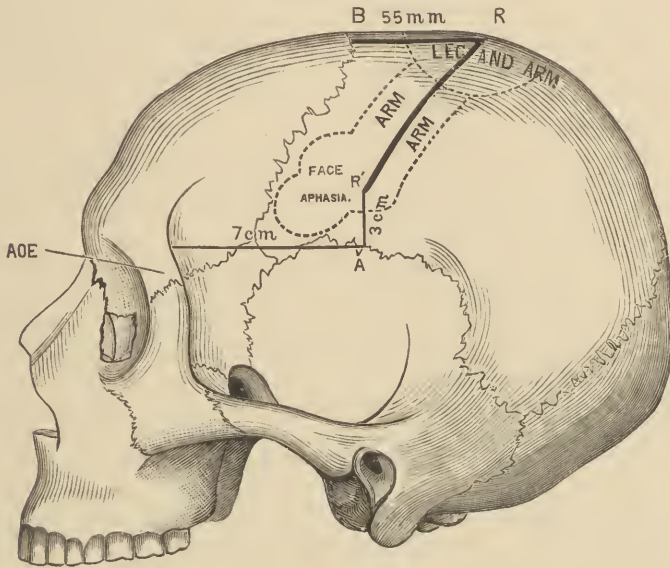


Diagram showing localization of cerebral nerve-centres and determination of line of Rolando
(Modified from Lucas-Championnière.)

arm. Paralysis of the arm and face. Paralysis of the upper and lower extremities. The palsies are more apt to be limited than those of pathological origin. Thus oftentimes the upper extremity is alone affected. Again, incomplete motor paralysis may alone be detected. They often vary in their intensity, according to the greater or less degree of inflammatory complication, or the amount of compression. Spontaneous cures of traumatic paralysis are very rare, although it may improve up to a certain point. More often it increases, and merges its phenomena with those of secondary paralysis. Secondary hemorrhage into inflamed or softened brain-tissue, probably accounts for certain cases of paralysis of intermediary origin. After operation, the paralysis may either suddenly or gradually disappear, but the inflammatory phenomena pass away only gradually. In some rare instances the paralysis disappears or diminishes after operation, only to return at a later period, and to be followed by atrophy. Here the cerebritis has gone on to secondary atrophy instead of to repair. Thus it is clear that irritation and compression of a centre not only suppress its function, but may lead to secondary degeneration, whence the advisability of active interference whenever the functions of a centre are distinctly involved.

Traumatic palsies are usually complete at the outset. They are often preceded, followed by, or alternated with convulsions. The convulsions are not often general at first. They usually commence in one limb. When they become more extended, there is commonly an aggravation of the general condition. Sometimes the paralyzed member is alone affected; at other times it is uninvolved. Generalized convulsions closely resemble those of epilepsy, and

are met with in fractures outside of the motor zone. Too little is known of their nature, significance, etc., to warrant any definite statements. As a result of traumatism, true epilepsy, hysteria, or even the convulsions due to apoplexy, may occur. Convulsions are of diagnostic value in direct proportion to their limitation.

Total hemiplegia cannot have a cortical origin, and therefore contra-indicates operation,¹ unless it has been incomplete at the outset, is irregular, and coincides with a very extended depression of the bone covering the motor region of the opposite side. Then a trephine-crown may be applied upon the middle of the line of Rolando, when, if the appearance of the dura mater warrant it, still more bone may be removed.

Monoplegia, or spasms limited to one member, or to a portion of a member, indicates limited lesions. If the lower limb be affected, the upper portion of the ascending parietal convolution, with perhaps also the corresponding part of the ascending frontal, is involved. A trephine-crown must then be applied about the upper part of the Rolandic line.

With paralysis of the arm and leg, the lesion probably involves the upper two-thirds of the ascending convolutions or the paracentral lobule. The trephine should then be placed at the upper part of the line, a little lower than in the preceding case. It may perhaps be necessary to enlarge the opening by cutting out another circle lower down.²

Paralysis of the upper extremity alone, probably indicates injury to the middle third of the ascending frontal convolution, and the trephine should be applied a little in front of the middle third of the line of Rolando.

Paralysis of the lower part of the face points to lesion of the inferior third of the ascending convolutions, or of the foot of the second frontal. Here the trephine should be placed a little in front of the inferior third of the Rolandic line.

In all the above instances, one portion of the periphery of the cut should cover the line of Rolando.

Immediate aphasia after injury of the left side of the head, is probably the result of the pressure of a bony fragment or a clot of blood. Should aphasia occur within a few days or weeks, it is probably due to abscess, and although the operation may prove of doubtful value, it may be attempted. The surgeon must never forget, however, that this symptom may result from a lesion extending from the primary injury, seated perhaps at some distance from the speech centre.

In simple aphasia, the trephine-crown should be placed lower down still, in front of and below the inferior extremity of the line (see Fig. 1090). Fortunately, in most cases many centres are attacked, and consequently the surface to be exposed is much larger. Thus:—

With paralysis of both lower extremities, the summit of the line, and the contiguous superior portion of the cranium, must be removed; with paralysis of one upper and one lower extremity (hemiplegia), the operation must be performed at the middle and upper portion of the line; in paralysis of the arm with facial palsy, the trephine is to be applied at the inferior third of the line, and a little in front; in palsy of the upper extremity with aphasia, the opening should be made below and in front of the line; with facial paralysis and aphasia, the bone should be removed well in front of the line, and below its inferior extremity (see Fig. 1090). The above, following Lucas-Championnière, give all the possible combinations, and the proper positions at which

¹ Brain-abscess excepted, when operation is indicated.

² MacEwen (Glasgow Medical Journal, Feb. 1884) reports a successful trephining over the middle third of the ascending frontal and parietal convolutions, for hemiplegia the result of syphilitic disease.

to apply the trephine according to the present state of science. These statements are subject to revision with advancing knowledge. Let the surgeon never forget that it is often necessary to remove large portions of bone to free the injured centres, and to obviate secondary inflammation. Following Gross and Seguin, I shall now proceed to give certain general indications and contra-indications.

Indications.—When hemiplegia occurs after a blow upon the head, or hemiplegia with hemispasm, however slight be the injury—provided that it is in the temporo-parietal region, even although it be not directly over the motor area—the surgeon is justified in exploring that area.

In the coma resulting from intracranial hemorrhage—from the middle meningeal artery for instance, as already pointed out—cerebral localization should guide the surgeon's hand unless in those instances where the effusion is so large as to present no limited compression-symptoms, when the operation should be conducted upon the principles laid down when considering intracranial extravasations of blood.¹ In those cases where the paralysis is on the side of injury, that is, the result of hemorrhage or fracture by counter-stroke, provided that laceration of the brain seem improbable, an operation over the motor area of the side opposite to that of injury would seem indicated. This must be a rare condition, and is too often complicated with cerebral laceration at or near the site of the external injury itself.²

Contra-indications.—Lesions of the base of the brain, as indicated by paralysis of one or more cranial nerves, neuro-retinitis, or Cheyne-Stokes respiration, I consider, with Gross and Seguin, to be positive contra-indications in otherwise favorable cases.

Hemiplegia accompanied by marked anæsthesia contra-indicates operation, as the latter symptom indicates lesions which implicate other portions of the encephalon than the motor area, and which are too deeply seated to be accessible to operative interference.

How is the line which corresponds to the fissure of Rolando to be mapped out in the living head? There are several methods, the least complex of which I shall now describe.

The head should be shaved, and then placed so that the alveolo-condyloid plane shall be horizontal. With a little care this can be readily done, even with the patient lying down. The next and most important point is to find the bregma. This can oftentimes be felt, but there are two devices which render its detection certain. The most accurate is the "flexible square" of Broca. (Fig. 1091.) A little behind the point of junction of the arms is a smooth, conical plug, which is to be introduced into the external auditory meatus. The horizontal branch of the square is then placed beneath the column of the nose (as in Fig. 1092), when the posterior border of the vertical arm will indicate the bregma. According to Broca, the bregma is at the front border of this line, but Lucas-Championnière has ascertained that this point is too far forwards. A ready method of finding the bregma, suggested by the latter author, is indicated in Fig. 1093. A piece of pasteboard is cut out so as to fit the shaved head, astride of which it is placed, passing across both auditory meatuses. A pencil is passed through it at right angles, at the level of the eyes, so as to ascertain whether the head is in a horizontal position; the middle of the pasteboard, marked B, will then indicate the bregma.

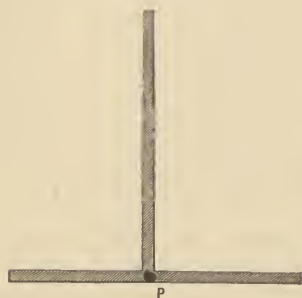
Having determined this all-essential point, measure backwards 5.5 centi-

¹ See page 44, *supra*. I must here express my indebtedness to the monograph of M. Lucas-Championnière, and to the summary of the subject by Dr. Seguin in the last edition of Prof. Gross's *System of Surgery*, vol. ii. p. 41 *et seq.*

² See Prof. S. W. Gross's case, page 46, *supra*.

metres in man, or 5 centimetres in women (BR), which will give the upper extremity of the Rolandic fissure.¹ Next measure backwards a horizontal line, 7 centimetres in length, from the external angular process of the frontal bone where it begins to curve upwards to form the temporal ridge (Fig. 1090).

Fig. 1091.



Flexible square of Broca. P. wooden plug to be introduced into auditory meatus. (After Lucas-Championnière.)

Fig. 1092.



Flexible square applied. B, bregma. (After Lucas-Championnière.)

Fig. 1093.



Ready mode of determining position of bregma. (After Lucas-Championnière.)

Upon this elevate a perpendicular line A R', 3 centimetres long, which will give the lower point of the fissure of Rolando; connecting these two points by the line R' R, we have the whole fissure defined with sufficient accuracy. The line should be distinctly marked upon the shaven scalp with an aniline pencil, or with strong tincture of iodine. Even when there is marked œdema, steady pressure with the finger will readily make out the bony point required. As a large-crowned trephine should be used for all operations where we seek to expose individual nerve-centres by the rules of cerebral topography, any little inaccuracy in measurement, which may be unavoidable, proves of no great moment.

In conclusion, I would remark that the whole subject of cerebral localization is yet in its infancy; that what has been said must be considered as provisional; but that by the light already gained, a few surgeons have succeeded in operations, solely guided by cerebral topography, while more have been partially guided, as I have been in two instances; and that in the past operations have been refrained from, and still more will be in the future, which a knowledge of cerebral localization may show to be useless.

TREPHINING.

It is of the first moment to ascertain the danger inherent to the operation itself. For this purpose it is useless to refer, as is commonly done, to such statistics as those of Fritze, 53.98 per cent.; of Pirogoff, from 60 to 70 per cent.; of Le Fort, 56.22 per cent.; of Otis, 56 per cent.; of Bluhm, 51.25 per cent.; and of Bermann, 46 per cent. of mortality. My reasons for making this sweeping statement are, that, as shown by W. J. Walsham in his admirable paper on the dangers of trephining, investigation proves that in many

¹ Broca, Seguin, and most authors say only 5 centimetres, but Lucas-Championnière insists that this is not enough.

instances death has been due to injuries other than those of the head, such as rupture of the renal vein, of the liver, etc. In many others, the post-mortem examination has shown that death has resulted, not from the operation, but from the injuries for which the trephining was done. In some cases, which have been quoted at second or third hand, trephining was not performed, but mere elevation of fragments with no removal of sound bone, while in a few no operation at all has been done.

To obtain, with anything like an approach to accuracy, the actual death-rate, we must resort to a series of cases where the operation has been performed upon persons in good health, without concomitant cerebral traumatism. The nearest approach to this is where the operation has been done for epilepsy, persistent pain in the head, etc., where the patients have been otherwise in good health. When death results in this class of cases, the operation must certainly be chargeable with it. An examination of the extended statistics of Mr. Walsham, combined with the results of other cases which I have added, show that the immediate mortality only amounts to 10.69 per cent., for out of 159 cases but 17 have proved fatal.¹ That statistics are easily manipulated I am aware; but, as far as I know, these cases have been taken just as they have come. I could add others which might make the exhibit more or less favorable, but the figures quoted are the most extended, and at the same time the most trustworthy, that I am acquainted with. I have added 37 cases of operation for epilepsy and insanity to the 122 of Walsham. Through the kindness of Prof. W. T. Briggs, of Nashville, I am in possession of the details of 33 operations for epilepsy or insanity performed by him, and the details of the remaining 4 cases are also known to me. These figures are therefore more valuable for determining the mortality of the operation, *per se*, than those of Billings's or Eccheverria's tables of operations for epilepsy, in which details are, for the most part, wanting. The latter writer, too, includes cases of recent head injury, to which the term traumatic epilepsy is not strictly applicable. These were doubtless cases of epileptiform convulsion from contusion of the brain, etc., and of course increase the apparent mortality of the operation. For similar reasons, the statement of the mortality of operations for traumatic epilepsy, which will be given hereafter, is not derived from either Billings's or Eccheverria's tables, but from a series of cases with the details of which I am familiar.

A further examination of those cases of which the details are sufficiently accurate, show that in 85 cases where there was no wound or fistulous tract, 72 ended in recovery and 13 in death, a mortality of 15.29 per cent. In 40 additional cases, where a fistula communicated with the dead bone, or an intracranial abscess existed at the time of operation, 39 patients recovered and only one died, a death-rate of 2.5 per cent. In the aggregate of statistics above given, of 159 cases, the mortality of 10.69 per cent. probably fairly represents the risk of the operation *per se*, as it is done for fractures and acute head-injuries, some of which are compound, some of which are made so—as in trephining for simple fracture—and in some of which more or less ancient suppuration exists. I think likewise that the death-rate of 15.29 per cent. may be taken as a guide as to the risks of trephining in simple depressed fracture, that is to say, that it expresses the risk of the operation *per se*, exclusive of that which attends the concomitant intracranial injuries.

The correct appreciation of the share which trephining has in conducing to a fatal result in cases of acute traumatism, such as compound fracture, is

¹ Briggs, Trans. Am. Med. Association, vol. xxxi. 1880, and personal communication from author; Walsham, St. Barth. Hosp. Reports, vol. xviii. p. 220; Byrd, Proceedings of the Am. Surgical Association, 1884.

in any given case a more difficult matter. The following propositions, which, of course, are only approximately true, may aid in the solution of this difficulty.

1. When death occurs from intracranial inflammation, the disease must, if due to the operation, have first started in the bone and dura mater, whence it has spread to the arachnoid, pia mater, and cortical substance of the brain, but very rarely to the white matter.

2. If the intracranial inflammation has its starting point in the brain, both the cortical and medullary portions will probably be involved, and thence the diseased process will extend outwards to the pia mater, arachnoid, etc. In addition, when of traumatic origin, the cerebral substance will probably present either signs of recent contusion or laceration, or traces of such injuries if the case be of some standing.

3. If then, in a given case, laceration or contusion of the brain, and inflammatory involvement of both the medullary and cortical portions of the cerebrum—the inflammation not involving more than the arachnoid membrane—coexist with a healthy condition of the dura mater around the trephine-hole, death certainly has not been hastened by the operation.

4. When intracranial inflammation has existed prior to operation, the operation cannot be justly charged with the fatal result.

5. When the time of onset of intracranial inflammation has been doubtful—that is, when it is uncertain whether it preceded or followed the operation—any opinion as to the effect of the latter upon the result of the case must be purely conjectural. General surgical principles, however, would suggest that inflammation would be more apt to result from contusion of the diploë, with a ragged, shattered state of the bone—which condition necessarily involves defective drainage—than from a clean trephine-cut, with its facilities for ready escape of the wound-fluids.

6. Great caution should be exercised in drawing conclusions in these cases, since the most severe injuries are sometimes recovered from without complications, while the slightest in appearance have at times proved fatal.

From want of knowledge of the actual death-rate of uncomplicated trephining, together with failure to recognize the facts embodied in some of the propositions just stated, and from the unreliable character of the statistics which have been published, as shown by Mr. Walsham, prominent surgeons differ as to the advisability of trephining. Those who are impressed with statistics gathered from any and every source, and unaccompanied by details to show whether operation or concomitant injury has been the cause of death, reprobate the operation; while those who have carefully investigated the matter are gradually reviving the procedure, so that there is reason to hope that it will soon be established on a surer foundation than ever before. I would premise, before giving the results of Mr. Walsham's and my own carefully compiled statistics, that many of the operations included were performed at a time when all operations exhibited a higher rate of mortality than at present. Thus, out of 748 cases there died 276, a percentage of 36.9 per cent.¹ My own experience has taught me that trephining *per se* is not a dangerous operation, and that more patients commonly die from complications which might have been prevented by a timely operation, than from the removal of a disk of healthy bone.

When should the trephine be used? As early as possible, in order to anticipate the secondary inflammatory affections which result from the irritation caused by fragments of bone, and from the impossibility of irritating fluids

¹ Amidon's statistics and estimate of the dangers of trephining (Med. Record, June 14, 1884), are, I am convinced, too low, the result of omitting unfavorable cases which legitimately should have been included.

draining easily away. When is it too late to trephine? Never—since a sufficient number of cases have recovered after trephining for cerebral abscess, than which nothing can be more dangerous; indeed, I myself saved, for the time, one patient who had ceased to breathe for some minutes, and who was only resuscitated by artificial respiration, the use of the battery, etc.¹

The grounds of my belief are found in the following statistics: Of 150 cases of preventive trephining, collected by Walsham, Briggs, and myself, only 33, or 22 per cent., proved fatal, while, on the other hand, 66 deaths, or a mortality of 52.8 per cent. followed 125 operations performed after the super-vention of symptoms indicative of brain-disease produced by the skull-injury. I freely admit that the average of cases of preventive trephining may possibly have been less severe than that of the secondary cases, but I think this highly improbable, since, in the severer ones, the patients would hardly have survived until a later date. With the details of the greater number of these cases I am familiar, and they go rather to prove the severity of those in which the operation was preventive. It is in accord with sound surgical principles to expect that preventive trephining should succeed, since by removing sources of irritation we may prevent intracranial mischief which, once initiated, the trephine is usually powerless to relieve, simply because it rarely can do more than remove *one* source of irritation, while others, and the more dangerous, that is, inflammation and its products, cannot be thus favorably influenced in the majority of instances. A cerebral abscess may be successfully evacuated, but much more commonly the operation fails; and the form of intracranial suppuration usually met with is diffused, not circumscribed. Therefore, I repeat, trephine early when possible, but here, as in other cases, use judgment. The indications for trephining for intracranial extravasation of blood, intracranial abscess, and depressed fracture, will all be found under their appropriate headings.

METHOD OF PERFORMING THE OPERATION.—I shall include, under the term trephining, all operations which involve removal of more or less sound bone,

Fig. 1094.



Conical trephine.

Fig. 1095.



Ordinary trephine

whether by the trephine, bone-forceps, or Hey's saw.² The special instruments required are an elevator,³ a knife with raspatory attached,⁴ trephines of various sizes (Figs. 1094, 1095), a pair of stout forceps, a trephine-brush (Fig. 1096), a

¹ He died six and a half days subsequently from exhaustion, the result of his second attack of erysipelas within three weeks. (See page 84, *supra*.)

² Scultetus's saw, in reality.

⁴ See Vol. III., p. 564, Fig. 633.

³ See Vol. III., p. 566, Fig. 644.

pair of Hey's saws (Figs. 1097, 1098), and gouge-forceps¹ (*rongeur*, as it is sometimes called), or a pair of small, cutting bone-forceps.² Some surgeons prefer to use the lenticular (Fig. 1099), to elevate the bone and smooth

Fig. 1096.



Trephine-brush.

Fig. 1097.



Fig. 1098.



Two forms of Hey's saw.

Fig. 1099.



Lenticular.

edges of the trephine-cut; but I have never seen any necessity for its use, as an elevator in careful hands is perfectly safe, and its rough, serrated edges serve admirably to file away, as it were, any inequalities left by fragments of the brittle inner table, which may have been left at the periphery of the aperture. The *rongeur* is an admirable instrument, and, where it can be used, serves a better purpose than the trephine or Hey's saw, in removing an overhanging shelf of bone, while it is a more rapid and safer instrument. Of the two forms of trephine, the conical, commonly called Galt's, is the safer, since from its form it is almost impossible for it to injure the brain, if, as the last portions of the inner table are divided, undue pressure should be made; while under these circumstances the old form of instrument has occasionally been accidentally plunged into the brain-substance. There is a theoretical objection to the conical instrument—viz., that from the uneven division of the outer and inner portions of the skull, necrosis is more apt to occur—but I am unaware of any facts to support the assertion that such is the case. The instruments should be placed in a solution of carbolic acid, one part to twenty of water, and the scalp cleansed by a solution of turpentine two parts, alcohol fourteen parts. The sponges should be kept in corrosive sublimate, one part to two thousand, with which solution the wound also should be kept more or less constantly irrigated.

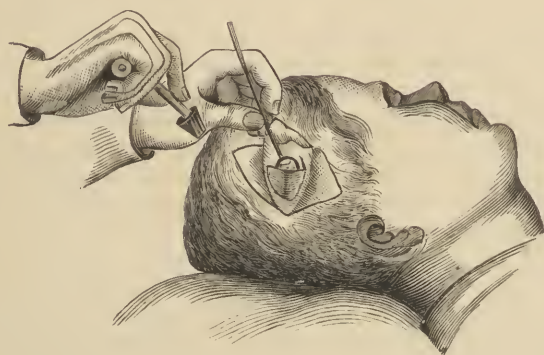
In most cases of compound fracture, flaps formed by incisions, regulated somewhat by the original wound, will readily expose the bone; indeed, in

¹ See Vol. III., p. 566, Fig. 641.

² A few American surgeons are enthusiastic in their advocacy of the dental engine instead of the trephine in removing portions of the skull. Having had no personal acquaintance with this method of operating, I can neither commend nor condemn it.

some cases none are needed. Where there is no wound, crucial, V-shaped, or, which I greatly prefer, a horseshoe-shaped incision, should be made. Any bleeding which does not spontaneously cease in a few moments, should be arrested with *serre-fines*, or by the application of a piece of dry antiseptic lint, which will, by the pressure of an assistant's fingers, stanch the blood. Ligatures may be used if preferred, but are usually unnecessary. The periosteum should next be incised, carefully separated by the raspatory or knife-handle, and kept out of harm's way, so as to avoid, as much as possible, the risk of future necrosis. The trephine, with its centre-pin protruded about one-sixteenth of an inch, and firmly screwed in this position, should be now applied to the portion of bone which it is intended to remove. The instrument should be worked with a light, sharp, quick movement from left to

Fig. 1100.



Application of the trephine.

right, and from right to left, care being taken not to press unevenly, and the pressure being chiefly exerted as the hand is carried from left to right. As soon as a sufficient groove has been cut to steady the trephine, the centre-pin should be withdrawn, and fixed so as to avoid injury to the *dura mater*. When the outer table of the skull is cut through, the bone-dust, which up to this time has been dry, becomes soft and bloody, as the instrument penetrates into the *diploë*. Both the sound and feel are also different. Where the use of the centre-pin is undesirable, Dr. P. H. Watson, of Edinburgh, has suggested that the instrument should be steadied by applying it through a perforated piece of pasteboard, firmly held against the bone. The trephine should be removed from time to time, and cleansed in the carbolyzed water, either by the brush or a sponge. The detritus lying in the bony groove should be removed by a tooth-pick or the flat end of a probe, advantage being taken at the same time to measure the depth of the cut at various portions of the circumference, to ascertain whether the bone is being evenly divided. If one segment of the groove be deeper than another, the trephine must be inclined towards the shallow side, and pressure made at that point alone until the groove is of equal depth throughout. The surgeon must remember that the bone is frequently of unequal thickness at various parts of the circumference of a trephine-cut, so that while the osseous disk may be firmly held fast at some point by portions of the inner table, the teeth of the instrument may at other points be tearing the *dura mater*, the chief thing to be avoided. When the instrument reaches the inner table, both the sound to the ear and the sensation conveyed to the hand usually give warning. Great care

should now be exercised, and each turn must be made cautiously and with very light pressure. By a slight rocking movement of the trephine, the looseness of the piece can be ascertained; but it is better to lay the instrument aside, and seizing the edge of the disk in the grasp of a pair of stout forceps, gently move it from side to side. If loosened at one edge, the trephine teeth must be made to cut upon the opposite, attached part, for a turn or two, when the forceps should again test the stability of the disk. When loosened, the bone may come away in the crown of the trephine, but I think it safer to remove it by tilting the piece out with the forceps, using a rocking movement, and always drawing it out towards that side where any portion of the inner table remains unsawn, as then the dura mater escapes the slightest injury from the other thoroughly sawn and perhaps splintered edge of bone. Any portions of the inner table that are left behind, can be removed with the forceps, elevator, or lenticular.

If the case be one of punctured fracture, a trephine large enough to include the starring of the outer table should be used, when most of the fragments will come away at once. Great care must be exercised in removing splinters of the inner table, lest the dura mater or venous sinuses be wounded. In the case of an ordinary depressed fracture, the trephine should be applied so that only about two-thirds of the circumference of the cut will be located upon the sound bone. A trephine of only sufficient size to enable an easy introduction of the elevator should be used. If after the removal of a disk of bone sufficient room have not been obtained, free use of the gouge-forceps or Hey's saw will usually suffice to enlarge the opening; otherwise, a new segment of bone must be removed with the trephine. If the fracture is near a sinus which we suspect may have been wounded by the depressed fragments, the trephine-cut should be so planned as to give free access, if necessary, to any bleeding point. When operating for blood or pus within the cranium, a trephine with a large crown is preferable. Abernethy suggested, that at the very outset of suppurative osteomyelitis a disk of the outer table only of the skull should be removed with the trephine, so as to give free vent to the unhealthy pus. The advice is theoretically good, and has been approved by Lidell, but I am not aware that it has ever been put in practice.

Performed for whatever purpose, all loose fragments of bone should be removed, depressed pieces elevated, but allowed to remain *in situ*, unless evidently so much denuded of pericranium and dura mater as to be likely to become necrosed, and the edges of the opening in the skull smoothed as far as practicable, with the gouge-forceps, or file-surface of the elevator, so as to lessen the risk of ulceration of the dura mater. If the sinus-like veins of the diploë bleed, a pellet of softened wax will readily arrest the flow, if the point be accessible. I was once compelled, on account of the very free hemorrhage, to pass a pledget of lint beneath the margins of an irregular opening of the frontal bone, when the inner table and diploë were broken for a considerable distance beyond the outer table, and to leave it there between the dura mater and bone for twenty-four hours. The bleeding in this case was so free that I had not time to remove the bony edge to reach the source of hemorrhage, which burst out as soon as I had elevated a large fragment. The patient recovered.

In another instance, where I successfully removed nearly the whole of the left temporal fossa, for a terrible crush of this part, after taking up and tying with fine catgut one or more branches of the middle meningeal artery, which lay in the dura mater, I was finally compelled to fill the whole wound with corrosive-sublimate cotton, and lay down the flaps to arrest the free oozing; this case also ended in recovery.

After arresting hemorrhage, the wound should be freely and repeatedly

washed out with the mercuric-bichloride solution, and the flaps laid in place and kept in position by straps or sutures. Means for free drainage must be provided, either by the arrangement of the flaps or by a small drainage tube. Over all, several layers of mercuric or carbolic gauze, or layers of lint soaked in the mercuric or carbolic solution should be placed and retained by the gentle pressure of a well-applied bandage. The dressings should be frequently changed, lest pent-up pus beneath the flaps should prove a cause of cerebral oppression. The after-treatment should be strictly antiseptic as far as the wound is concerned, and should be that of a bad cranial fracture as regards the head symptoms. Eccheverria recommends the administration of conium and ergot after trephining for epilepsy, with the constant application of the ice-cap to the head for a number of days, after which frequent cold affusions may be substituted. A head-cap, formed of a continuous coil of block-tin pipe, through which iced water is kept constantly flowing, is the most satisfactory way of applying dry cold.¹

It is unadvisable to apply the trephine over the course of sutures, if it can be avoided, simply because the dura mater usually adheres at these points with exceptional tenacity, rendering tearing of that membrane a probable accident, and, also, because of the great difference in the thickness of the bone; thus, along the sagittal suture, which is grooved for the longitudinal sinus, at one portion of the periphery of the trephine-cut the teeth would almost certainly touch the dura mater, while at other portions the bone would be only half sawn through. In cases where it seems imperative to apply the trephine over a suture, especially one beneath which lies a sinus, there is, fortunately, very frequently a separation of the dura mater produced by the injury, which removes it out of harm's way. Notwithstanding, when possible, sutures should be avoided. In like manner, trephining over the anterior inferior parietal angle is undesirable, lest the middle meningeal artery should be wounded. If this happen, plugging the bony canal with a sharpened match, or a pellet of wax, will usually arrest the bleeding. If not, a knitting-needle or iron wire at a dull red heat may be made to effectually seal the vessel. The course of the lateral sinus, which, in a general way, may be said to correspond to a line drawn from the external occipital protuberance to the external auditory meatus, should also be avoided.

Trephining over the frontal sinus, it is said, must never be done except under compulsion, lest an aërial fistula result. This presupposes that the cavity is always present and in the same position. Mr. Hilton² has shown that the sinus does not begin to make its appearance before fifteen or sixteen years of age, and that in many cases it may not begin to be developed until a still later period. Examining different adult crania, he found these cavities sometimes altogether absent. Oftentimes but one small cell was found on *one* side of the median line, while in other cases there was a small cell on either side. In other specimens there were fair sized cavities, at times symmetrical, but usually differing much in outline and dimensions. Sometimes the sinus may extend upwards nearly the whole distance of the forehead, and backwards an inch or more along the orbital plates of the frontal bone. An aërial fistula does not always result;³ still, when possible, the supposed site of the frontal sinuses should be avoided. When it is not possible, a large-crowned instrument must be used to perforate the outer wall of the sinus, and a smaller one for the inner.

Finally, when there are imperative reasons for so doing, the surgeon may trephine at any point of the skull, bearing in mind the special dangers to be

¹ See, also, Petitgand's apparatus, Vol. II. p. 175, Fig. 287.

² Guy's Hosp. Reports, 2d series, vol. viii. pp. 362 *et seq.*

³ See Larrey, *op. cit.*

avoided in certain localities, and remembering that there is no such thing as an invariable rule in surgery. Sometimes Hey's saw or the gouge-forceps can be with advantage substituted for the trephine. With these instruments, a projecting angle of bone may be removed, or a strip of bone sawn from an overhanging edge, so as to permit the introduction of the elevator and the restoration of depressed fragments to their normal level, or to allow their successful removal.

The skullcap varies in thickness from one-fifth of an inch, upon the average, to as much as three-fourths of an inch at the occipital protuberance. In the young child, the diploë may be absent, whence great caution must be exercised in those rare cases in which the operation is required in the very young.¹ In the old, the bone is often much thinned by absorption. The advice of Holden is admirable: "Think that you are operating on the thinnest skull ever seen, and thinner in one portion of the circle than the other." The trephine-hole is usually closed by fibrous tissue, sometimes by fibro-cartilage, and, very rarely, by a more or less complete, thin plate of bone. Sometimes the bony margins thicken, forming a raised ring, while at other times they become thinner, and blend with an imperfect ring of osseous tissue which extends into the fibrous membrane, thus closing the opening to a varying extent.

As an exceedingly rare secondary complication of trephining, I would mention hemorrhage from the middle meningeal artery. Thus, Mr. Jackson reports a secondary and uncontrollable bleeding from this vessel, which required, six weeks after trephining, ligature of the carotid artery. The patient recovered.²

TREPHINING IN EPILEPSY.—Each case of this disease must be judged by itself. All that I shall attempt, therefore, will be to give the mortality and probability of success attendant upon operative interference, with the indications which have induced surgeons to trephine, in this condition.

Causes: Lesions found in the Bone and Dura Mater.—The cause of the lesions inducing epilepsy has been in the majority of instances the application of great violence to the skull, but many times the reverse has been noted. When the result of great violence, the disease has usually been due to depressed bone-fragments. When the exciting cause has been a slight injury, the lesions usually observed have been chronic inflammation and thickening of the bone, leading perhaps to the formation of an exostosis. Finally, merely inflammation and thickening of the dura mater or pericranium have been the sole lesions detected in a number of cases. Sometimes the convulsions have been the result of a slight injury which has detached a small fragment of the inner table. "Where mania, idiocy, or other form of mental deterioration occurred, the lesion may be said generally, to have existed in the anterior half-segment of the cranium; where paralysis was present, the parietal, with exception of two cases, was the part injured, the lesion, however, in both of these exceptional cases being so far back as to be practically in the parietal region."³

The onset of the disease has been, in a few cases, immediately after the injury, but in the majority a variable period has elapsed, in a few cases as much even as thirteen years. In proportion to the duration of the disease is usually the impairment of the intellect, from which the important precept may be drawn, to trephine early, since, although some of the cases of longest duration and of gravest character have been entirely relieved by operation,

¹ A child, twelve months old, has been successfully trephined for a punctured fracture of the skull, produced by a large nail. (Gross, op. cit., vol. ii. p. 88.)

² Brit. Med. Journal, November 1, 1876.

³ Walsham, St. Bartholomew's Hospital Reports, vol. xix. p. 139.

most patients, according to Walsham's statistics, are only improved, are unrelieved, or die.

Symptoms Indicating Operation.—Pain in the head, mostly located at or about the injured spot, has been present in most instances. Out of a total of 82 cases collected by Mr. Walsham, in 3 there were no local indications, while in 44 a depressed cicatrix or a depressed spot, painful or tender on pressure, existed. In some, the cicatrix or depressed spot was merely sensitive, in others the seat of constant pain.

Pressure at these points produced in 2 cases vertigo, in 1 convulsions, and in 1 rigidity; in 1—a point worthy of future investigation—the temperature was 3° F. higher at the tender spot than elsewhere upon the cranium. In 8 cases there was neither cicatrix nor depression, but a tender, painful, or sensitive spot, pressure upon which caused pain, vertigo, or convulsions. In 8 cases there was a fistulous tract leading down to dead bone. In 3 patients a fissure was felt in the bone. In 2 there was a bony elevation. In 2 there was a tumor or swelling of the bone. Eleven operations were said to have been performed at the site of a former wound or injury. In one instance there was no scar or any other local indication, but from the symptoms trephining seemed indicated over the fissure of Rolando, and was there successfully applied.¹

In the majority of cases, depressed bone was discovered at the operation, or the osseous tissue was found variously altered and diseased. Where carious or necrosed, a sinus generally led down to the bone. The dura mater was usually found healthy, but in other cases was thickened, congested, vascular, or adherent. A strange fact is, that in 16 cases nothing to account for the epilepsy could be detected, and yet in 10 such cases, in which recovery took place, 7 patients were cured, 2 were relieved, and only 1 was unrelieved. In one of the cases in which the patient died unrelieved, an undetected bone-fragment was found after death to have caused the failure of the operation.

Results ; Prognosis.—In 48 of the 82 cases under review a cure was effected, the patients being restored to good health ; 13 patients were relieved, some of whom may ultimately have been really cured, as they were steadily improving when last heard from.² In a certain proportion the fits persisted at first, and gradually disappeared. Four patients were not improved, and 17 died. In certain of these deaths the fatal termination occurred so long afterwards as hardly to be fairly attributable to the operation.

Taking the whole number of cases collected by Walsham, and 37 added by myself, making in all 167, 32 ended fatally, a mortality of 19.16 per cent. As to the prognosis, with regard to recovery from the epilepsy, etc., the cases above referred to, where the details are given, furnish the only thoroughly trustworthy data which are available.

If there is a distinct history of injury, a well-marked cicatrix, or a sinus leading down to dead bone, and if the epilepsy has undoubtedly been initiated by the injury, there can be no doubt of the propriety of operating after the failure of medical treatment. So simple an operation as mere removal of the cicatrix and pericranium, will in certain cases permanently relieve epilepsy, as in a patient of Dr. J. Ewing Mears, of Philadelphia. Portal cured one case of epilepsy by excising a cicatrix upon the thumb, and another by a similar operation upon a scar of the scalp. The amputation of injured toes, lithotomy, and evacuating the contents of a wounded eye have also cured epileptics. In most of these cases a so-called aura has been present, starting in the point

¹ Walsham, loc. cit., p. 133.

² One of the cured patients in this list was reported at first as only unimproved, yet a later report showed that he had had no fits for years.

operated upon. Wherever similar expedients seem indicated they should therefore be tried, if depressed bone be not manifestly the exciting cause. With Mr. Walsham, I would add, as to doubtful cases where the indications are not clear, that with the fact before us that, in many cases where the history of an injury has been obscure, or where no history whatever has been obtained, or where the only local indication has been a sensitive, painful, or even a tender spot without any evidence of depression or inequality of bone, patients have been rescued from a miserable existence and restored to one of health and comfort, "I think we may go further, and say that even with such slight indications the trephine ought to be used; and holding as I do that the operation is one in itself not attended, when the membranes are not wounded, with much danger, I would give the patient the benefit of the doubt, and would myself press the operation."¹ What if at the operation nothing be found? Wait for some months, and then, if no improvement take place, the operation may be repeated near the site of the first, remembering that in one case mentioned, an undetected fragment of the inner table was found, after death, to be the cause of the disease. As to the operation itself, Prof. Briggs, whose experience is greater than that of any other operator in this country, points out that, to be successful, all the thickened and diseased bone should be removed. In one of his cases he successfully cut out six large buttons of bone with the intervening osseous tissue. Prof. Briggs also calls attention to the very important fact that after removal of the bone, we should still watch the case, lest some other source of peripheral irritation should arise, such as a painful cicatrix, which would then require excision. One of the sources of failure in operations for epilepsy, is the neglect of after-treatment, medical as well as surgical. The operation indeed removes the most important cause of the epilepsy, but only one cause. The disturbed circulation in the nervous centres, and the excessive mobility of the nervous system, can only disappear with time; and if all other sources of peripheral irritation are not most carefully guarded against, the patient may be slightly if at all benefited, whereas judicious after-treatment will sometimes relieve an apparent operative failure.

INJURIES OF THE CRANIAL NERVES.

As a consequence of head injury, one or more of the cranial nerves may have its functions suppressed, either temporarily or permanently. This may result from various causes: (1) the nerve may be divided by the vulnerating body, as in thrust-wounds of the orbit or nose, or in penetrating bullet-wounds of the head; (2) by laceration of the brain-tissue, the nerve may be torn from its centre; (3) it may be torn across by the fissure of a basal fracture, traversing the foramen through which it passes out of the cranium, or the bony canal in which it lies; (4) it may be compressed by displaced fragments of bone; (5) it may be compressed by blood, either effused into its sheath, or along its course through the skull; (6) the deep origin of the nerve may be destroyed or compressed by effusion, either hemorrhagic or inflammatory.

The olfactory, optic, and orbital nerves, are those most frequently lacerated by thrust-wounds, etc. Injuries from such a cause are rare. Owing to the frequency with which the petrous portion of the temporal bone is involved in fractures, injuries of the facial and auditory nerves are of common occurrence. Palsies of these nerves in undoubted fractures of the petrous bone do not always appear at first, nor are they persistent, which shows that they are by no means certain signs of a basal fracture. When loss of function is

¹ Walsham, loc. cit., p. 143.

produced by hemorrhagic pressure, or by that of inflammatory products, gradual recovery not uncommonly ensues. I shall now briefly allude to the injuries of each special nerve, and the consequent lesions—if any—produced in distant organs.

FIRST PAIR, OR OLFACTORY NERVES.—A fracture involving the cribriform plate of the ethmoid must almost of necessity injure the olfactory nerves. Owing to the excessive softness and delicacy of these nerves, and to their being firmly held against the under surface of the anterior cerebral lobes by the arachnoid, injuries which tend to drive the anterior portions of the brain against the bony floor of the anterior cranial fossæ, may readily injure the olfactory bulbs. According to Dr. Ogle, blows upon the occiput—as in two cases reported by him—may rupture the nerve-filaments as they pass from the bulb through the foramina in the cribriform plate of the ethmoid bone. Hemorrhage into the neighboring portions of the anterior lobes, or surrounding and compressing the nerve between the bone and brain—to judge from results—is a much more common cause of loss of smell than basal fracture. I have seen one case of anosmia, in private practice, the result of a probable fracture of the base of the skull. Four years after the accident, when I first saw this gentleman, all sense of smell was absolutely lost, and this had been so since the date of the injury. Brodie reports two cases of anosmia after head-injury. In one, there commenced some time after the injury a gradual restoration of the sense of smell, which steadily went on until a perfect cure resulted; in the other, examined many years after, complete loss of smell persisted. In an excellent paper, Mr. Henry Lee¹ relates a case showing how caution must be exercised in determining the presence or absence of anosmia. A patient in St. George's Hospital appeared for several weeks to have lost the sense of smell upon the left side, after a traumatism of the head which had resulted in facial paralysis. Finally, a more careful examination showed that, owing to the combined effect of a deviated nasal septum and paralysis of the dilator naris, etc., the left nostril had practically become impervious to air; when, however, the left nostril was held open, the man perceived odors with equal facility upon each side of the nose. Anosmia is sometimes said to coexist with loss of taste, but this is a mistake. True *sapors*—that is, exciters of the sense of taste, such as salt, acids, or bitters, which are non-volatile—can be readily tasted after complete destruction of the first pair of nerves. Those substances which depend chiefly upon volatile *odors* for their so-called taste—and to odor most articles of food owe their palatableness—can no longer be distinguished from tasteless or even disagreeable substances. This was the case with the patient that was under my care. From the proximity of the centres of speech and smell, anosmia and aphasia not uncommonly coexist.

SECOND PAIR, OR OPTIC NERVES.—The optic nerve may be torn through by a fracture traversing the orbit; may be compressed by hemorrhage within the neurilemma; may be crushed by a displaced fragment of bone; or may be divided by a penetrating wound. Of the first method of causation, a case reported by M. Pigné is a good illustration. Here, from the application of a powerful compressing force, that is, the passage of a carriage-wheel over the head, the orbital roof was extensively comminuted, resulting in a complete tearing across of the optic nerve and of all the recti muscles.² As an instance of a displaced fragment of bone suppressing the function of the optic nerves,

¹ Medical Times and Gazette, new series, vol. iv. p. 238 *et seq.* 1852.

² Bull. de la Soc. Anat. de Paris, p. 228. 1837.

Brodie relates the case of an old man, run over by a cart, who with a depressed fracture of one parietal bone complained of total blindness. After death, fragments of the sphenoid bone were found compressing both optic nerves, just behind the orbits.¹

Hewett says that there are, in St. George's Hospital Museum, two optic nerves derived from the same patient, where the neurilemma was distended with blood, thus producing compression. He says that he has found this condition in several instances after severe injuries of the head, and especially after those near the orbits. The nerve-sheath was in these cases distended with blood, which had escaped from the veins contained within the neurilemma. This observation of Sir P. Hewett serves to explain the gradual recovery of sight which takes place after certain head-injuries, where primarily vision has been lost.² M. Duponchel reports a case where the optic nerve was divided by a penetrating wound of the orbit:—

A dragoon was wounded in a duel by a sabre-thrust. After death it was found that the weapon had passed beneath the globe of the eye, and had completely divided the optic nerve.³

THIRD PAIR; OCULO-MOTOR NERVES.—Although from their relations, this pair of nerves is less liable to be torn by osseous fragments than those just mentioned, it is quite often compressed by extravasated blood. While all the parts supplied by this nerve may be paralyzed, it is much more frequent for the levator palpebræ to be alone affected, resulting in complete ptosis. Still more strange is it to learn, that one branch of the upper division of the nerve, with another branch of its lower division, may be alone affected. In a case which I have already related to illustrate another point, the third nerve upon the left side was compressed by an enormous clot of blood proceeding from a ruptured middle meningeal artery, and during life the left pupil was widely dilated.⁴ Brodie⁵ relates an interesting case in which recovery ensued, and as, though the paretic condition of the pupil persisted so long, complete restoration eventually took place, it may not be amiss to give here an abstract.

A gentleman received a severe contusion of the head by a fall from his horse, which rendered him insensible; and the fact that the loss of consciousness persisted for several days, showed that the cause was some form of compression. When consciousness began to return, ptosis of the right upper eyelid was observed, with a completely dilated pupil, which did not contract with the stimulus of light. It was only after the lapse of nearly a year that the right pupil returned to its normal condition.

Those cases where vision is said to have been affected in injuries of the third nerve, are probably not due to any accompanying lesion of the optic nerve, but to the state of the pupil. If such be the case, a stenopaic slit, or pinhole through a card, will render a differential diagnosis easy, provided that no original difference from refractive anomaly existed in the eyes previous to the accident. An ophthalmoscopic examination would, in these latter circumstances, be necessary to determine whether the impairment of vision, after the use of a stenopaic apparatus, was due to injury, or to congenital or acquired defect of refraction.

¹ Med.-Chir. Trans., vol. xiv. p. 348.

² Gaz. des Hôpit., p. 446. 1854.

³ Bull. de la Soc. d'Émulation, 1822; quoted by Aran.

⁴ See, also, Aran, Archives Gén. de Méd., 4e série, tome vi. p. 338; Pick (Left third nerve compressed in sella turcica by blood clot), Brit. Med. Journ., May 27, 1865.

⁵ Brodie, loc. cit., p. 354.

FOURTH PAIR ; PATHETIC NERVES.—Owing to the protected position enjoyed by these nerves, they seem never to be injured ; at least I have not been able to find a record of any such accident.

FIFTH PAIR ; TRIFACIAL NERVES.—These nerves not uncommonly suffer in head-injuries, and usually in conjunction with lesions of some other cranial nerve.¹ All the branches of the nerve are rarely involved, but more than one are usually affected.

A man was rendered completely insensible by a severe blow upon the left side of the head, inflicted by a heavy piece of timber. Much blood was lost from the ears, nose, and mouth. Regaining consciousness upon the following day, right hemiplegia and ptosis of the left eyelid were noted. Seven weeks afterwards, upon admission to St. George's Hospital, he complained of severe pain upon the left side of the head ; the ptosis persisted, and there was a purulent discharge from the left ear. The hemiplegia had almost entirely disappeared. There was total loss of sensibility in all parts supplied by the left fifth nerve ; he could neither taste nor feel upon the left side of the tongue, except at its root ; a probe was not felt in the nostril of that side ; and cutaneous sensibility was absent over the whole left side of the face, upper part of the head, etc. Gradual improvement ensued, but the cornea became opaque, owing, perhaps, to the eye remaining partly open and without sensation, thus allowing foreign bodies to lodge within the lids and there remain a constant source of irritation. He could close the eye when directed to do so.²

Another interesting case is on record, where, after a severe injury, both sensation and motion of the right side of the face were seriously impaired. In about two weeks, the conjunctiva of the right eye became chemosed ; the cornea had lost all sensibility ; it was cloudy, and presented, at its lower part, appearances of an interlamellar abscess. Soon slight ulceration commenced over the site of the abscess, extending until, between two and three months after the injury, the cornea gave way with a loss of only the aqueous humor. The cornea finally cicatrized, and the patient could see through its upper segment. Ultimately, both sensation and motion of the right side of the face were restored.³

Where recovery ensues, the paralysis has probably been due to hemorrhagic or inflammatory deposit ; where the loss of function is permanent, tearing of the nerve, or permanent pressure by displaced bone, is probably the cause. Why in some cases corneal ulceration takes place, while in others it does not, is a much vexed question which it is beside our present purpose to attempt to elucidate.⁴

SIXTH PAIR ; ABDUCENT NERVES.—This nerve being small, and lodged in a groove upon the upper portion of the petrous part of the temporal bone, is liable to be torn across in fractures implicating this part of the base of the skull.

Paralysis of this nerve is apt to coexist with a similar condition of some of the other cerebral nerves. Recovery has ensued in several such cases, where not only the abducent nerve has been affected, but where other cerebral nerves were at the same time paralyzed.

Aran reported a case where, after a violent blow upon the head, the right abducent nerve was completely paralyzed. He considered that the lesion

¹ Thus Hulke (*Lancet*, Nov. 30, 1878, p. 769) reports a case in which, after death, the right portio dura and the fifth and second nerves were found to have been torn.

² Lee, *Med. Times and Gazette*, new series, vol. iv. p. 240. 1852.

³ Richard, *Gaz. des Hôpitaux*, 1844. I quote this case on the authority of Hewett (*op. cit.*, vol. i. p. 616), having failed to gain access to the original report.

⁴ See Dixon, *Med.-Chirurg. Trans.*, vol. xxviii. p. 373 *et seq.*

was produced by a fracture of the cranial base.¹ Still more striking as an illustration is the following:—

A man, aged forty years, fell from a height of twelve metres upon his feet. He experienced only some slight symptoms of concussion. Omitting unnecessary details, among his other symptoms he had internal squint of the right eye. Dying about four months subsequently, an extensive fracture was found, implicating the clinoid processes and the right petrous bone, a considerable fragment of which was entirely detached from the rest of the skull. The sixth nerve was torn by the edge of the broken bone.²

SEVENTH PAIR; FACIAL AND AUDITORY NERVES.—(1) *Portio Dura or Facial Nerve.*—The long, bony canal in which the greater part of the intracranial segment of the facial nerve is lodged, occupying as it does the petrous portion of the temporal bone, renders its tearing or compression an almost necessary consequence of fractures of the middle fossæ of the skull. Indeed, paralysis of this nerve has been from time out of mind considered to be a valuable sign of fracture of the base of the skull. Loss of function of this nerve is, however, not conclusive proof that a fissure has traversed its bony canal, for it may be due, as in a case observed by Hewett, to the pressure of a small clot of blood in the common sheath between the facial and auditory nerves. Again, in undoubted fracture this nerve may not be affected at first, showing that its paralysis in basal fracture may be due to mere irritation by the broken fragments and subsequent inflammatory pressure, rather than to tearing, thus explaining—remembering that absorbable blood-clot may also compress the facial nerve—the gradual recovery of function that may ensue after the most strongly-marked paralysis. Pick reports that of ten cases of facial paralysis after basal fracture, in only two was it present at the time of the patient's admission into the hospital, while in the remaining eight cases the nerve-affection appeared from the second to the sixth day.³

(2) *Portio Mollis or Auditory Nerve.*—For similar anatomical reasons to those given for the facial, the auditory nerve is not uncommonly injured in fractures of the cranial base. Recovery from such injuries being rare, it is not often that deafness from fractured skull is observed.

The following case, reported by Aran,⁴ illustrates how the portio mollis may be torn while the portio dura of the seventh pair remains intact, although included in the same bony canal for a part of its course. The reverse is also equally true, but is explicable by the longer and more tortuous course pursued by the facial nerve through the temporal bone.

A young man fell from a height of twenty feet, and lost consciousness. On the fifth day, a fracture of the temporal bone was diagnosed from symptoms which I need not detail. Death took place on the sixth day, and at the autopsy, among other injuries, a fissure was found traversing the petrous bone so as to tear the auditory nerve.

EIGHTH AND NINTH PAIRS; GLOSSO-PHARYNGEAL, PNEUMOGASTRIC, SPINAL ACCESSORY, AND HYPOGLOSSAL NERVES.—Intracranial injuries of these nerves are of rare occurrence, owing to their passage through short, bony foramina, the first three in conjunction with the large, soft, compressible jugular vein. These are also protected in their intracranial course by one of the largest of the subarachnoid spaces, which is filled with a fluid that readily becomes displaced when blood is extravasated. After persisting for a time, symptoms due to traumatic affections of these nerves may disappear. Owing to the emergence of the three first mentioned nerves through the same foramen, their affections must be considered more or less together.

¹ Arch. Gén de Méd., 4e sér., tome vi. p. 338.

³ British Med. Journ., vol. i. p. 530. 1865.

² Ibid., p. 191.

⁴ Aran, loc. cit.

Mr. Hilton, in his lectures upon fractures of the cranium, relates one case where, with lesions of other cerebral nerves, the result of a severe injury to the head, the patient exhibited great difficulty of deglutition; the "tongue was thrust over to the other side; articulation was slow, and enunciation very imperfect." Pain in the neck, upon the affected side, extending as far as the clavicle, was complained of. Recovery, leaving only slight traces of paralysis, took place after the lapse of a few months.

Aphonia, dysphagia, dyspnoea, with contraction of the muscles accessory to respiration, and more or less paralysis of the pharynx, œsophagus, and stomach, were the main symptoms presented by a patient who recovered from a brain-wound, in which the glosso-pharyngeal, pneumogastric, hypoglossal, spinal accessory and suboccipital nerves were divided by the thrust of a lance.

Finally, I shall give an abstract of the voluminous notes of Mr. Hilton on a case of basal fracture in which the fragments became secondarily displaced, causing compression of the eighth pair of nerves.

A man with basal fracture of the skull was admitted into Guy's Hospital, and did well until the tenth day, when, after getting out of bed and walking across the ward, he had rigors, followed by vomiting, and gradually lapsed into semicoma. Later in the day, dysphagia, with a gasping respiration, was noticed. The difficulty of deglutition rapidly increased, until before morning "everything was rejected as soon as it reached the pharynx." Death resulted within forty-eight hours from coma and asphyxia. Post-mortem examination revealed a healthy state of the brain and its membranes; there were signs neither of inflammation nor of injury of the brain-tissue. The line of fracture passed through the right jugular foramen, whence it ran across the base of the skull, dividing the posterior part of the cranium into two portions, which freely moved upon one another. The fragments were displaced in such a manner that the right cerebellar fossa was lower than the left.¹

Doubtless some motion made by this patient in walking across the ward caused the bony displacement which resulted in his death. This resulted from asphyxia, as was the case in a patient of Agnew's. In Hilton's case it is a matter for regret that no examination of the lungs was made, to determine whether there were actually pulmonary lesions as in Dr. Agnew's patient, and as in one of Verneuil's.²

In Agnew's case, irregular, labored, noisy respiration, with great dulness upon percussion over the back of the chest, was noticed during life, and after death a blood-extravasation into the medulla oblongata, that is, into the pneumogastric centre, was discovered, with intense engorgement of both lungs.³

Erichsen says that he has seen "repeated vomitings with palpitations, and a sense of suffocation continuing for months after an apparent injury to the origin of the pneumogastric. In other cases, from lesion of the spinal accessory, spasm of the trapezius and sterno-mastoid muscles, simulating tetanus, may set in."⁴

Treatment.—Any special therapeutic measures seem uncalled for, since, if the lesions are due to blood-extravasations or inflammatory products, nature will suffice to cause their absorption. Mercury, blisterings, etc., are commonly recommended, but I question their efficacy. Iodide of potassium in the later stages may prove beneficial. Electricity, if resorted to at all after

¹ Two cases are given by Sir C. Bell (Lectures on the Nervous System, Am. ed., p. 202. Cases LXII. and LXV. 1833), where sudden death resulted from secondary displacement of fragments of the occipital bone at the foramen magnum, causing pressure upon the medulla oblongata. These are cited as somewhat analogous cases, since they demonstrate the possibility of secondary displacement of bone being a cause of nerve-compression.

² Lancet, Nov. 30, 1878, p. 769.

⁴ Erichsen, op. cit., vol. i. p. 551.

³ Agnew, op. cit., vol. i. p. 278.

head-injuries, must be most cautiously used, and not until a late period if we would not renew the previous cerebral disturbance.

SECONDARY AFFECTIONS OF THE BRAIN.

These result quite as often from slight as from severe injuries. They come on at variable periods after the occurrence of the primary lesion. The same may be said with reference to the time of appearance of the symptoms indicative of cerebral complication. Defects of memory are among the most common after-effects of head-injuries, and these may be the sole evidences of cerebral disease, or the amnesia may be associated with other affections. In most instances the patient forgets only recent events, but at times the whole history of his past life is a blank. All power of speaking a well-known language may be lost, the patient using that of his childhood. He may forget his own name, or his residence. Again, the patient may give the most circumstantial and minute account of the way in which he was injured, upon one day, only to contradict it upon the next; and can sometimes be led to say in good faith almost anything that his interrogator pleases, as in a case related by Erichsen. This is of great importance as a medico-legal fact. The patient's disposition may be completely altered, a gentle, quiet demeanor being exchanged for a captious, morose, or quarrelsome temper. Sleep may be broken by frightful dreams. The mind may become generally weakened, so as to be incapable of the slightest exertion. Cephalalgia, vertigo, and tinnitus aurium may also be complained of. Aphasia is a not uncommon occurrence, especially if the anterior cerebral lobes be affected. There may be also agraphia, and loss of the power of articulation. Occasionally the patient loses both memory and speech. All these troubles may be evanescent, but loss of speech and memory is only too apt to be permanent.

INSANITY, apt to be permanent, is a not infrequent sequel of so-called concussion. I have seen one case where, after as long a period as three months of mental alienation, at times so marked as to require bodily restraint, the mind ultimately seemed completely restored. Some few of these cases can be relieved by operation, as in the famous instance recorded by Cline, where, after a depressed fracture of the superior portion of the left parietal bone, trephining, eleven months subsequent to the injury, restored consciousness and voluntary motion.

IMPAIRMENT, DISORDER, OR LOSS OF THE SPECIAL SENSES is quite common, but special sensation may be at times exalted. Instances have been reported, such as those quoted by Prof. Gross, where deafness of long standing has disappeared after severe concussion of the brain.

UNNATURAL SLOWNESS OF THE PULSE, probably due to lesions of the medulla oblongata, the crura cerebri, or the pons Varolii, is an occasional result of concussion of the brain. This cardiac slowing may last for months, the condition coexisting with a peculiar irritability of the heart, so that under excitement the pulse becomes very rapid—again resuming its subnormal rate of frequency upon cessation of mental or other irritation.

CHANGES AFFECTING THE DIGESTIVE ORGANS.—An icteroid hue of the skin is a rare sequel. Nausea and vomiting, or obstinate constipation, have been sometimes noticed to persist for a considerable time after a head-injury. Gross thinks that when obstinate and prolonged gastric distress is present, there has

probably been direct involvement of the pneumogastric nerves or their centres. Although the appetite remains good, emaciation and loss of strength, due to defective assimilation, mark the after-course of certain head-injuries.

URINARY CHANGES.—Cases are met with in which abnormalities of the renal secretion are more or less marked. Thus irritability of the bladder, retention or incontinence of urine, with a marked increase of the amount secreted—that is, traumatic diabetes—may all be noticed. The diabetes mentioned is usually of the saccharine variety, comes on soon after the accident, and persists only for about eight or ten days in most instances. This is not invariably the rule, irritable bladder, etc., with marked diabetes insipidus, sometimes persisting for months. As a result of severe injuries of the skull and brain, albumen, with or without a diminution of urea, may be present in the urine.¹

The amount of saccharine matter in traumatic diabetes is usually small, and its presence has been variously ascribed to an injury of the floor of the fourth ventricle, to defective oxygenation of the blood, etc.

GENITAL CHANGES.—An occasional, early effect of blows upon the head, especially of its posterior portion, has been violent sexual excitement with incessant erections. It appears most probable, according to the latest investigations, that this, as well as impotence, is due to injury of the medulla oblongata, rather than of the cerebellum or cerebrum.² Atrophy of the testes may or may not accompany impotence.

PARALYSIS OF SOME OF THE FACIAL OR OCULAR MUSCLES is not uncommon. Want of co-ordination of certain muscles, muscular twitchings, and paralysis of a single finger, of the hand, or of a limb, may also occur.

As one of the causes of these various symptoms, Gross calls attention to a calcification and necrosis of the nerve-cells of the brain, described by Virchow, in which the cell-processes and even the fine nerve-fibres of the brain-cortex may sometimes be also calcified, as a result of so-called concussion. In the vast majority of cases, however, the symptoms are due to local congestions or inflammations of various parts of the encephalon, the result of injury to the brain or its envelopes, to intracranial hemorrhages, or to the effusion of inflammatory products, and secondary changes, such as sclerosis. The paralysis may also be due to compression or lesion of the cranial nerves, and not to any cerebral injury proper.

Treatment of Secondary Brain-Affections.—This is involved in that of the injuries which give rise to the secondary results. Over and above this, attention to the state of the bowels, careful regulation of the diet, change of air, and, at a later stage, tonics, hot or cold douches—or alternations of these—with perhaps sea-bathing and electricity, may prove useful. Quietude of mind and body should be enforced. A prolonged course of iodide of potassium, with or without mercury, may be tried. When local congestions seem to be the cause of the symptoms, ergot should be exhibited, and dry or even wet cupping should be resorted to. Prolonged counter-irritation, by setons and issues, has been recommended upon high authority. In conditions of the pathology of which we know so little, such remedies seem to me of doubtful propriety, and having no personal experience of their use I do not recommend, but merely mention them, as said to have proved remedial in the hands of others.

¹ Albumen, according to Huguenin, is more commonly found in the urine than sugar. A case of Verneuil's, already quoted, presented distinct evidences of both sugar and albumen in the urine.

² Harkin, Practitioner, Feb. 1884, p. 98.

[ADDITIONAL REMARKS ON THE MECHANISM OF FRACTURES OF THE SKULL BY
INDIRECT VIOLENCE: THE "BURSTING THEORY."

A few words must be given to a theory in regard to the mechanism of fractures of the skull, which appears to have originated about the middle of the last century with Sabouraut, Chopart, and other French surgeons, and which has been more recently revived by Félizet, in France, by Messerer, Wahl, and Greder, in Germany, and by Dulles, in this country. This theory, which has been called the "bursting theory," is based upon a well-known law of physics, that if an elastic sphere is compressed in one diameter, it is necessarily widened in those diameters which are at right angles to that which is shortened. The effect of violence applied therefore to any part of an elastic case like the skull, is to approximate the point of impact with that diametrically opposite to it—this being drawn in, as it were, to meet the point struck—and to separate all parts which are equatorially related to the diameter thus shortened. As a fracture always begins in the line of extension, the bones of the skull commonly give way in some meridional line, the particular locality depending upon the strength of the different parts, and the mechanical conditions as to position, etc., under which the violence is applied. An exception, which is apparent only, is met with in certain rare cases in which the skull is broken only at a point more or less directly opposite the point of impact, the explanation here being that the meridional parts are more resisting than that which sustains the fracture, and that this has occurred inwards, the line of extension being, under these circumstances, on the inner surface of the skull.

This theory appears to me to be reasonable, and to be founded on accepted physical laws, and I have myself taught it to my classes for many years; nor do I think it inconsistent, as it is often maintained to be, with a proper application of the "vibratory theory," as adopted by Dr. Naucerede in the body of this article. The force applied to the skull is undoubtedly transmitted to all other parts by vibrations originating at the point of impact, and whether the skull shall give way where struck, or at an opposite or at a meridional point, depends upon so many factors varying with the individual injured and the particular circumstances under which the violence is inflicted, that no rules can be laid down which can be applied with mathematical certainty in all cases.]

MALFORMATIONS AND DISEASES OF THE HEAD.

BY

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DISEASES OF THE SCALP.

ERYSIPELAS.—The head is very frequently the seat of erysipelas. In 692 cases of erysipelas, collected by Zuelzer,¹ the disease was met with on the head in 246 instances. On the scalp it usually assumes the simple cutaneous form, the morbid changes extending no deeper than the aponeurosis of the occipito-frontalis muscle; on the face, however, the subcutaneous structures are almost invariably involved; and great swelling of the parts is produced. Erysipelas of the scalp may also be “cellular” (cellulitis) or “cellulo-cutaneous.” Scalp erysipelas usually extends to the face, and face erysipelas to the scalp. Erysipelas of the head may (1) be either idiopathic, or (2) have for a starting-point some wound, ulcer, or chronic skin-disease involving breach of surface. The great bulk of the cases of so-called idiopathic erysipelas occur in this situation, and commence usually on the face, extending subsequently to the scalp. Trousseau² and others very rightly question the spontaneous character of this form of erysipelas, and urge that in all but a few cases some slight lesion can be detected—a scratch, or a trifling sore upon the skin, a breach of surface on the nasal mucous membrane, or within the mouth, or the auditory meatus, or even in the lachrymal canal. And with regard to these latter sources of erysipelas, it is to be noted that the reputed idiopathic disease most commonly commences about the orifice of some mucous cavity. Scalp wounds are more commonly followed by erysipelas than are wounds elsewhere. As in other parts, it is most frequent after recent wounds, and more common after small wounds than large. This latter fact is explained by the probable neglect of treatment in smaller wounds.

Symptoms.—These are the same as those of erysipelas elsewhere, with some few modifications.³ The constitutional disturbance is often considerable, and nausea and vomiting, as concomitant symptoms, appear to be unduly frequent in erysipelas in this situation (Zuelzer⁴). Certain *cerebral symptoms* also commonly appear. Headache, often of severe character, vertigo, drowsiness, or, on the other hand, undue excitement, may be among the earliest constitutional evidences of the disease. As the malady advances, more serious symptoms may supervene, the more usual being sleeplessness, mental confusion, extreme restlessness, or delirium, often of a furious character. These symptoms are usually dependent upon some hyperæmia of the pia mater, and may appear in any form of head erysipelas, independent of cause or extent.

¹ Ziemssen's Cyclopædia of the Practice of Medicine, vol. ii. p. 457. 1875.

² Lectures on Clinical Medicine, 3d ed., vol. ii. p. 253. 1869.

³ See Vol. I. pp. 177, 184.

⁴ Loc. cit., p. 460.

In many fatal cases of head erysipelas with brain symptoms, this hyperæmia has been the only cerebral change noticed at the autopsy. In some cases thrombosis of the cerebral sinuses may occur, producing distinctive symptoms. Nothnagel¹ states that such thrombosis is due to extension from some phlebitis of the surface (scalp or skull). *Meningitis* is rare in erysipelas, and when it does occur is usually suppurative, and due either to metastasis, or more commonly to direct extension of suppurative inflammation from the bones or soft parts. Huguenin has only observed it in cases where suppuration existed. When it occurs it is associated with the usual symptoms—the patient dying with convulsions, paralysis, coma, etc. Certain *ocular symptoms* may occur in erysipelas of the head, especially when it involves the orbital region. The most common are conjunctivitis and photophobia, the latter often due to cerebral hyperæmia; in some cases the cornea has ulcerated, and has led to perforation and subsequent wasting of the globe (Wagner). Cases also are recorded of complete suppuration of the globe. In many instances a disturbance of vision exists, which, as a rule, perfectly disappears during convalescence, and is ascribed by Heineke² to an œdema of the orbital connective tissue. Amblyopia, neuro-retinitis, and optic atrophy, are reported as occasional sequelæ, the last named being the most frequent.

The *local symptoms* have these peculiarities: The inflammation extends with unusual rapidity; yet, although the entire head and face may be involved, there is little tendency for the erysipelas to extend to the neck or trunk. The manner of extension is very irregular on the scalp, although Pfleger and Zuelzer³ have endeavored to establish some rules for its extension. If beginning from a wound, it commonly spreads centrifugally, but irregularly so; or, starting from the forehead, it may run transversely around the head to the point of commencement. Over the face it is usually very evenly distributed, the chin, however, remaining nearly always free. The redness is but very little marked on the scalp, owing to the tenseness of that structure and its hairy covering; the swelling also is inconsiderable, and is best noticed at the spreading edge of the erysipelas, where the redness also is best seen. On the face, however, the redness is most conspicuous, and the swelling, especially of the eyelids, often very considerable. Bullæ very rarely occur in scalp erysipelas, but are met with in face erysipelas, especially on the forehead, cheeks, ears, and over the mastoid process. Abscess is a rare sequela, especially on the scalp, and gangrene or sloughing are still more uncommon. In the eyelid, however, both these conditions are sometimes met with in cases that have been severe. The lymphatic glands behind the ear and below the occiput, are very constantly enlarged during the eruption. After the eruption has subsided, the hair usually falls off to a varying extent, but is in time perfectly renewed. Like erysipelas elsewhere, that of the head is liable to relapse and to recur.

Prognosis.—The prognosis is a little more grave than that of erysipelas elsewhere, owing to the probability of cerebral complications, and to the fact that the so-called idiopathic form is apt to occur in unhealthy or debilitated subjects, whose very ill condition has indeed predisposed them to the disease. In the great majority of cases, however, perfect recovery follows. Erichsen's⁴ statement that erysipelas of the head, "when arising from wound, is very commonly fatal; when it is idiopathic, it is very seldom indeed followed by death," is certainly not supported by other observers. The *duration* of head

¹ Ziemssen's Cyclopædia, vol. xii. p. 212.

² Pitha und Billroth, Handb. der Chirurgie, Band iii. 1873. Chirurgische Krankheiten des Kopfes (W. Heineke), S. 2.

³ For full account see Zuelzer, loc. cit., p. 451 *et seq.*

⁴ Science and Art of Surgery, 7th ed., vol. i. p. 701. London, 1877.

erysipelas is, according to Zuelzer (who speaks from a large collection of observations), on the average, 10, 12, or 14 days; less often, 6 days, and still more rarely does it become a matter of weeks.

Diagnosis.—The diagnosis of facial erysipelas presents no special difficulties, but when on the scalp its recognition is sometimes dubious, owing to the often scarcely noticeable amount of swelling and redness. The constitutional disturbance should arouse suspicion of erysipelas, and an existing injury of the scalp should direct attention to that part, when at the spreading edge the features of the disease would be obvious.

Treatment.—The treatment of head erysipelas presents little that is special.¹ The scalp should be shaved, all wounds kept scrupulously clean, and, as a local application, I should advise the constant use of lead and spirit lotion. The practice of multiple punctures is to be condemned. If any symptoms of cerebral hyperæmia appear, an ice-bag should be applied to the head, bromide of potassium administered, and the case treated on general principles. The eyelids, if they remain swollen, should be carefully examined for abscess, and immediate exit given to the pus, if present.

CELLULITIS.—Diffuse Phlegmon.—This term refers to a diffuse inflammation, very commonly erysipelatous, involving the loose layer of connective tissue lying between the aponeurosis of the occipito-frontalis muscle and the pericranium. It is usually due to a wound opening up that layer of loose tissue, but may depend also upon any deep ulceration, upon injuries without breach of surface, that lead to suppuration—for instance, fracture, extravasation of blood, etc.—upon various forms of bone disease inducing suppuration, and, lastly, upon the extension of erysipelas to the deeper parts. It is very doubtful if it is ever spontaneous, although Chassaignac² states that it may occur idiopathically during convalescence from cholera.

Symptoms.—About the affected spot a deep-seated swelling of the scalp appears, which extends somewhat rapidly, and is due to effusion in the sub-aponeurotic tissue. This swelling is at first hard, hot, tender, and painful. As it increases it becomes more brawny, and the parts more evidently œdematous. The extent of the swelling varies, but, as a rule, before it has attained any great size it becomes softer and boggy in spots; the skin, which has up to this time been of normal color (unless erysipelas exists), now becomes reddened; fluctuation, perhaps, is evident; and, at last, pus is discharged. With the evacuation of the pus much of the œdema subsides, and the local symptoms, which are often very severe, become less distressing. These local changes are ushered in and accompanied by symptoms of general disturbance, by rigors which are often repeated, by fever which may run very high, by sickness, headache, and general malaise. Cerebral symptoms, such as occur in erysipelas, may also be present, but, as a rule, all the constitutional symptoms subside considerably when the pus has found an exit. The extent of the local mischief varies. In some cases the whole of the scalp may be lifted up, and appear to rest upon a boggy stratum beneath. Suppuration occurs very early, often in two or three days, and resolution is extremely uncommon. The pus, as a rule, soon finds an outlet, and mostly this is situate in the temporal region or behind the ear, about the inferior limits of the aponeurosis. There are commonly several openings. Sloughs of the connective tissue are discharged or may be removed. Often the aponeurosis itself sloughs in larger or smaller portions, and in some cases the pericranium dies in part, leaving the bone bare, and the condition may be followed by very extensive necrosis. It is remarkable that sloughing of

¹ See Vol. I. p. 191.
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² *Traité Pratique de la Suppuration*, tome ii. p. 7. 1859.

the scalp itself is excessively rare in these cases, no matter how extensive may be its separation from the deeper parts. Facial œdema may exist, but will subside when the pus has had vent.

The *prognosis* is often grave, and open to much conjecture. Death frequently occurs, and in the earlier stages is usually due either to purulent infection or to an extension of suppurative inflammation to the meninges of the brain. Death has also occurred from hemorrhage due to the opening of an artery by ulceration.¹ If the disease is, on the other hand, protracted, the prolonged suppuration may cause a fatal issue. The duration and graveness of the case will depend much upon the original cause, the health of the patient, the extent of the suppuration, and the amount of sloughing; but, perhaps, the two most serious local conditions are imperfect discharge for the pus and extensive stripping of the perieranium. The latter condition is noted in a great majority of the fatal cases.

The *diagnosis* can be inferred from the above account. From simple erysipelas, cellulitis is distinguished by the absence of redness, the absence usually of gland enlargement, the greater degree of the local swelling, and the more severe symptoms. Its diagnosis from acute perieranitis, which it may closely resemble, is detailed below.

Treatment.—In addition to the general treatment of diffuse cellular inflammation² the head should be shaved, and free incisions made the moment suppuration is suspected, or before that occurrence if the swelling be considerable or very tense. These incisions should be made at the most dependent spots possible, and as near to the attachment of the aponeurosis as the swelling extends. They should be so arranged as to avoid the scalp arteries, and to meet this end some advise radial incisions. Drainage with drainage-tubes should then be carefully and fully carried out, and a poultice applied to the entire scalp. All sloughs should be removed as soon as loose, and when they have all separated the poultice may be discarded for lead and spirit lotion. Throughout the entire case the various sinuses should be well irrigated with a weak carbolic solution at least twice a day, and any new collection of pus at once evacuated. When there is any tendency to bagging, pressure with a Martin's elastic bandage often answers well, but its use requires careful watching, as if applied too tightly it may add to the sloughing action. The drainage-tubes should be removed one by one as soon as the granulating cavity contracts around them, and then gentle pressure with a common bandage may be maintained for some time longer. Often these cases are very tedious, especially when any bone mischief exists; and sometimes (though rarely) the sinuses refuse to heal in spite of the treatment just indicated, and in the absence of any special complication. In one such case that came under my notice, suppuration had continued eighteen months when the accidental discovery of a piece of imbedded drainage-tube, that was supposed to have been removed more than a year before, led to its almost immediate cessation, and to perfect cure. In another case, under my care at the London Hospital, healing was prevented by the formation beneath the aponeurosis of a vast amount of gelatinous, ill-formed connective tissue. On enlarging the sinuses and scraping out this jelly-like matter, a rapid healing ensued. Many cases of protracted suppuration are due to the natural and constant movement of the scalp muscle, which prevents perfect coaptation of the surfaces, as pointed out by Mr. Hilton.³ He readily cured several chronic cases of this character by simply keeping the muscle at rest by strapping the scalp.

¹ Follin et Duplay, *Traité Élément. de Path. Ext.*, tome iii. p. 549. 1869.

² See Vol. III., p. 119.

³ For interesting accounts of these cases, see Mr. Hilton's "Rest and Pain," 3d ed., p. 139. 1880.

ABSCCESS.—Abscesses of the scalp may be met with in three situations: 1. In the scalp proper, above the aponeurosis; 2. In the lax tissue beneath the aponeurosis; and 3. Beneath the pericranium. Abscesses in the first and second situations are circumscribed, but suppuration beneath the aponeurosis is generally diffuse. Scalp abscesses may be due to many causes, principal among which are contusions, extravasation of blood in the various situations named, retrogressive changes in certain wounds, especially those that have rapidly healed at the surface, the breaking down of syphilitic nodes and of so-called serofulous deposits, suppurating cysts, and bone affections. Owing to the tension of the parts, scalp abscesses are apt to be associated with severe local symptoms when acute, and with much constitutional disturbance. These acute suppurations are readily diagnosed. A chronic abscess in the scalp may be mistaken for a sebaceous cyst, from which, however, it may be distinguished by its more rapid growth, its pain, its tenderness, its more distinct fluctuation possibly, and by the fact that it would feel to the touch more dense at the periphery than at the centre. A grooved needle, moreover, would clear up all difficulty. There is a form of superficial abscess, common in young serofulous children, that usually appears as a sequela of chronic eczema. These abscesses are small, often multiple, well circumscribed, and covered by very thin and purple integument. They are, as a rule, painless, and associated with little or no constitutional disturbance. They should be opened early; either by simple puncture, or, better still, by the actual cautery. They sometimes lead to troublesome serofulous ulcers. Suppuration in the tissue beneath the aponeurosis is apt to assume the character described under cellulitis, although not necessarily of so acute and rapid a course. It is seldom, however, distinctly chronic. Abscesses beneath the pericranium are difficult to diagnose early, and are generally associated with symptoms of bone mischief—necrosis or caries. They will be referred to hereafter.

Mr. Thomas Smith¹ gives an account of a remarkable abscess in a child aged 4 years, that happened to form over a congenital hole in the skull, in the upper occipital region. It assumed the form of a small, rounded, fluctuating tumor, that pulsated but was not reducible. At its base the deficiency in the skull could be felt. Other congenital holes could also be felt in the parietal bones. The abscess was let alone, and ultimately more or less disappeared. This case will be again alluded to in speaking of "Malformations of the skull." Follin and Duplay² allude to the great difficulty of diagnosing abscesses situated deeply in the temporal fossa and beneath the temporal muscles. The symptoms of such abscesses are most insidious, vague, and often misleading; fluctuation, even if observable when the muscle is relaxed, is at once lost when the jaws are clenched. It is important that all abscesses of the scalp should be opened early and as soon as detected, and this remark applies very especially to those beneath the pericranium, inasmuch as the longer they are left unopened the more extensively will the pericranium become separated.

ULCERS.—Many various forms of ulcer are met with on the scalp. Some follow upon injuries of various kinds, or upon simple eruptions, such as that of eczema. These require no special notice. The more important ulcers of the scalp are of spontaneous origin, and may be classed as (1) Syphilitic ulcer; (2) Strumous ulcer; (3) Lupus; (4) Rodent ulcer; (5) Epithelioma. Detailed descriptions of these ulcers will be found elsewhere, but the following points that affect their differential diagnosis may be here briefly stated.

(1) *Syphilitic ulcers* are usually limited to the tertiary stage of syphilis, and are most often met with on the forehead. They proceed either from some pre-

¹ Transactions of the Path. Soc. of London, vol. xvi. p. 224.

² Op. cit., tome. iii. p. 550.

existing eruption, commonly rapid, or from the breaking down of a gumma. The general features of these ulcers are that they are of rounded outline, or are annular in figure, or serpiginous; their edges are sharply cut, their bases usually level, and the skin around them of a dusky color that has been well compared to the color of raw ham. Those due to a previous eruption are often multiple, and usually superficial. Those due to gummata are preceded by a hard, irregular, somewhat painful lump, covered by adherent, purplish skin, that in time softens and forms an ulcer, the base of which presents the well-known "wash-leather" or cellular-membranous slough. These ulcers are apt to extend, and often expose the bone, and may then be associated with necrosis. They are all benefited by anti-syphilitic treatment.

(2) *Strumous ulcers* are met with in scrofulous children, and may be on any part of the scalp. There are, as a rule, more than one. They are preceded by a small, hard deposit in the scalp, covered with reddened skin. In time this mass indolently breaks down. The ulcer, when fully formed, is oval or roundish, with thin, undermined, purple edges, and a foul base often covered by exuberant granulations that readily bleed.

(3) *Lupus non-exedens* never occurs primarily on the scalp (Heineke¹), but may spread thereto from the face, ears, or mastoid region.

(4) *Rodent ulcer* usually appears on the forehead. It is uncommon before 45. The ulcer formed spreads deliberately and very slowly—so slowly that it takes years to effect an amount of destruction that would be accomplished by epithelioma in a less number of months.² Its edges are elevated, hard, sinuous, clean, with little adjacent induration, and none of the warty growth of epithelioma. The glands are scarcely ever affected. The bone may be exposed, and so extensively destroyed as to lay bare the dura mater.³

(5) *Epithelioma* of the scalp is rare, and most commonly appears on the skin of the forehead or frontal region. The ulcer formed grows rapidly, has indurated, everted, and most irregular, warty edges, and often an equally irregular base. Unlike rodent ulcer, it invades the glands, and, unlike the syphilitic ulcer, it is single.

With regard to the general *prognosis* of scalp ulcers, it must be remembered that any extensive or deep ulceration may cause death from cerebral complication, usually by inducing a thrombosis of the cerebral sinuses, or a meningitis of the convexity.

The *treatment* of these ulcers calls for no special mention in this place. Birkett records a case⁴ of successful removal of a large epitheliomatous ulcer over the right temple. Holmes relates a case⁵ in which he removed from the fronto-parietal region of a man aged 64, an epitheliomatous ulcer three and a quarter inches in diameter. The pericranium was exposed. The man died shortly after the operation with cerebral symptoms.

ANTHRAX.—This is extremely rare in the scalp. When it does occur, it is usually met with in the inferior occipital region, and is due to extension from the neck. The next most usual situation is the forehead. Anthrax of the scalp is especially dangerous by its tendency to induce cerebral complications. This is usually effected by a thrombosis of the sinus, produced by an extension of phlebitis from without. This thrombosis is then apt to end in purulent "phlebitis sinuum." Nothnagel⁶ gives an excellent account of

¹ Heineke, loc. cit., S. 8.

² Hutchinson, Illustrations of Clinical Society, vol. i. p. 14.

³ Erichsen (Science and Art of Surgery, 7th edit. vol. i.) gives a cut showing very extensive exposure of the dura mater in a man who had been afflicted with the disease for thirty years.

⁴ Trans. of Path. Soc. of London, vol. xix. p. 389.

⁵ Ibid., vol. xxiii. p. 277.

⁶ Ziemssen's Cyclopaedia of the Practice of Medicine, vol. xii. 221.

such cases. Purulent meningitis of the convexity may also, according to Huguenin,¹ be induced in a like manner. Sir Astley Cooper² "never saw a patient who recovered from any considerable carbuncle on the head." Since that statement was made, cases of recovery have, however, been recorded. I saw two years ago an extensive anthrax, involving the greater part of the forehead, that in time healed perfectly, with but trifling constitutional disturbance.

GANGRENE.—More or less extensive gangrene of the scalp may follow severe injuries, especially in the cachectic. I have seen extensive gangrene of the scalp over the frontal and occipital regions follow upon the application of a tight bandage. This had been applied to arrest bleeding from a frontal scalp wound, the patient being an intemperate, ill-conditioned woman, past middle life. Gangrene of the scalp may also follow upon diffuse cellular inflammation of the scalp, especially if the treatment by prompt incision be neglected. Sir Prescott Hewett,³ however, mentions a case of very considerable gangrene following cellulitis where early incision had been made. The patient was a woman of middle age, and the case ended fatally. Heineke⁴ states that in feeble, unhealthy children a very trivial cause may induce a partial scalp gangrene. It has occurred after slight injuries, after otitis externa, after eczema behind the ear, and after erysipelas. Mr. Thomas Smith⁵ has described an unique case in a little girl, aged nine. After an attack of erysipelas, a large piece of the left parietal bone came away by spontaneous necrosis, bringing with it a corresponding portion of the hairy scalp. The case did well. The treatment of gangrene in this situation requires no especial notice.

TUMORS OF THE SCALP.—In addition to those tumors described below under the special headings "Pneumatocele," "Hæmatoma," "Cysts," "Horns," "Vascular Tumors," and "Aneurism," the following growths are met with in the soft parts that cover in the cranium.

Fatty Tumors.—These are very rare. They may occur on any part of the scalp, and, although as a rule small, may attain a considerable size, and may even become pedunculated.⁶ In some cases they are congenital, or are at least noticed very early in life.⁷ Their origin—in most cases at least—appears to be from the loose connective tissue beneath the scalp aponeurosis, and they are frequently found to be adherent to the pericranium. As a rule, their growth is very slow, although in one case⁷ the tumor reached the size of half an orange in eighteen months. When of large size the diagnosis is very simple; but when small and beneath the aponeurosis the diagnosis is difficult, the mass often feeling very hard and adherent. In Mr. Sydney Jones's case the mass appeared to become tighter and more prominent when the child cried. These tumors give no trouble other than by their bulk, although some time ago I removed a small fatty tumor from beneath the frontalis muscle in a woman, aged thirty-one, that had been associated with intense neuralgia of the supraorbital nerve. The tumor was directly over the nerve. If these growths give any inconvenience they should be excised at once.

Fibrous tumors are also very rare unless they appear as the tumors of mol-

¹ Ibid., p. 603.

² Lectures on Surgery, vol. i. p. 243.

³ Lectures on Injuries and Diseases of the Head. Medical Times and Gazette, vol. ii. p. 200. 1855.

⁴ Loc. cit., S. S.

⁵ Trans. of Clin. Soc. of London, vol. iii. p. 163. 1870.

⁶ Bruns, Handb. der prakt. Chirurgie, Bd. i. S. 96. 1854.

⁷ Case recorded by Mr. Sydney Jones. The tumor was first noticed when the child was two months old. Lancet, Oct. 1880, p. 587.

luseum fibrosum, which are, however, as a rule, more of a fibro-cellular structure, and are not infrequent on the scalp. Sir Prescott Hewett¹ and Professor Gross² both describe cases of large fibrous tumors of the scalp, in each instance about the size of an orange. In Hewett's case, the mass was behind the ear, and hung down by a thick pedicle. In the other case the tumor was on the vertex. In both instances the fundus of the mass had ulcerated. Such tumors as these are readily removed if they occasion any trouble.

Pachydermatocoele ; Elephantiasis of the Scalp ; Hypertrophy of the Scalp.—A remarkable condition of the scalp has been described by different authors under one or other of these titles.³ There is now no doubt, however, that these terms have all been applied to one and the same disease. The disease consists in a remarkable overgrowth of the scalp tissues at some one spot. The mass thus formed hangs down as a huge, pendulous, bag-like tumor, often lobulated and thrown into transverse folds or creases, doughy and flabby to the feel, quite painless, and covered by normal skin. Dr. Mott, who gives an excellent account of these tumors, says that they are always congenital¹ and begin in a mole. Subsequent authors have, however, not confirmed this statement.⁴ These masses have occurred most frequently about the age of puberty and in young adults. In females they are more common about the occiput;⁵ in males about the temporal or parietal region. They grow slowly, and are innocent, causing trouble only by their bulk, which may be considerable. When they hang down from the temple, they close in the eye and drag down the mouth. In a case recorded by Sir E. Home, the tumor was larger than the patient's head.⁶ With regard to *treatment*, Thirion⁷ obtained a cure by the use of continued pressure and iodine applications; but no doubt the bulk of such cases must be treated by removal, if treated at all. One case so operated on was fatal from hemorrhage,⁸ and in one of Dr. Mott's cases⁹ the mass recurred twice, a circumstance explained by its imperfect removal in the first instance. Each operation must be planned to meet the particular case. If great bleeding be anticipated, the common carotid may be tied as a preliminary measure.

Osteoma.—Virehow¹⁰ records two cases of osteoma of the scalp, in patients respectively forty-eight and sixty-seven years of age. They had existed for a long time. These cases, however, were only examined clinically, and may be fairly open to question as to their real nature.

Papillomata of the scalp are extremely rare. They are probably always congenital, and commence from a minute wart or mole. They are most common about the frontal region, and present precisely the ordinary aspect of papillomata elsewhere. In a woman aged thirty-five, under my care at the London Hospital, there was a papilloma, measuring $3\frac{1}{2}$ inches by 3 inches, over the coronal suture just to the right of the middle line. It had grown from a minute mole. It was very prominent, slightly pedunculated, and gave issue to a thin discharge, having the peculiarly offensive odor of

¹ Medical Times and Gazette, vol. i. p. 315. 1862.

² System of Surgery, 5th ed., vol. ii. p. 115.

³ For some collected cases, see Bruns, Handb. der prakt. Chirurgie, Bd. i. S. 91; also a paper by Dr. Valentine Mott (Med.-Chir. Trans., vol. xxxvii. p. 154), including excellent drawings of the disease, and records of five cases—two being situated on the scalp. An excellent case will also be found in the Clinical Society's Transactions, Nov. 1876, reported by Mr. Walsham.

⁴ See, however, Gross, op. cit.

⁵ Follin et Duplay, Traité de Path. Ext., tome iii. p. 569. 1869.

⁶ See drawing in Med. Times and Gazette, vol. i. p. 315. 1862.

⁷ Revue Méd.-Chir., tome ii. p. 100. 1852.

⁸ Case quoted by Erichsen. Science and Art of Surgery, vol. ii. p. 384. 1872.

⁹ Loc. cit., p. 156.

¹⁰ Die krankhaften Geschwülste, Bd. ii. S. 65. 1864.

papillomata elsewhere. It was absolutely devoid of hair, and had the usual cauliflower aspect. As the hair had always been combed over the mass, its surface was flatter than is usual in these growths. The *treatment* should be the same as that for papillomata in other situations.

Sarcoma of the scalp is occasionally met with, although more usually the disease commences in the bone or in the dura mater ("fungus"). It appears to be usually of the spindle-celled variety, and to present the usual signs that distinguish sarcomatous growths elsewhere. Neither the *diagnosis* nor the *treatment* calls for any especial notice in this place.

Carcinoma usually assumes the form of epithelioma.¹ MM. Follin and Duplay² state that a malignant growth may appear in the deeper parts of the scalp having all the characters of scirrhus.

Solid Congenital Tumors.—In addition to the congenital dermoid cysts, certain solid congenital tumors are sometimes met with in the scalp. They are, as a rule, deeply seated, and adherent to the pericranium. In a case of Mr. Thomas Smith's, quoted by Holmes,³ the tumor was 2 inches by 1 inch in size, and was lobulated, hard, and purely fibrous in structure. Some of the less superficial tumors contain cysts, while those nearer the surface are quite solid. These growths appear to have the same general structure as have like congenital tumors elsewhere.

PNEUMATOCELE.—This term is applied to tumors formed by a collection of air beneath the pericranium, and due to a spontaneous perforation of the mastoid cells, or of the frontal sinus. To appreciate its exact nature, it is necessary to exclude from consideration all emphysematous tumors of the scalp.

Emphysema of the scalp may occur in connection with a more general emphysema of the cellular tissue of the body, or may be due to the decomposition of retained inflammatory products. *Localized emphysematous tumors* may also be due to fractures of the frontal, nasal, or ethmoid bones, and, also, according to Leduard,⁴ to a fracture of the temporal bone—in any such case a cavity containing air being opened up. Such tumors may also be due to necrosis of the frontal bone (Warren,⁵ Duverney⁶), or to like disease in the mastoid process (Prescott Hewett⁷). These tumors must not be confused with pneumatocele.

Only ten cases of pneumatocele have been put on record;⁸ of this number, nine occurred in the mastoid region, and are stated to have been due to opening up of the mastoid cells, and only one has been met with in the frontal region.⁹ Nine of the ten cases occurred in males. The average age of the patients was about thirty, the youngest being eighteen,¹⁰ the oldest forty-seven.¹¹

Symptoms.—When in the mastoid region, the tumor is situated behind the ear, although in Balassa's case it first appeared in the temporal region. Jarjavay's case was situated at the outer border of the orbit. Pneumatocele begins as a small, hard, rounded tumor, of regular outline, and covered by

¹ See page 116 *supra*.

² Op. cit., tome iii. p. 570.

³ Surgical Treatment of Children's Diseases, p. 28. 1868.

⁴ Quoted by Heineke, op. cit., S. 10.

⁵ J. M. Warren, Surgical Observations, chapter xiii. Boston, 1867.

⁶ Quoted by Heineke, loc. cit., S. 15.

⁷ Lectures on Diseases and Injuries of the Head. Med. Times and Gaz., vol. ii. p. 106. 1855.

⁸ An excellent abstract of all these cases will be found in Heineke's monograph, S. 11 u. folg. See, also, Costes, Moniteur des Hôpitaux, tome vii. Nos. 21–24. 1859; Louis Thomas, Du Pneumatocele du Crâne. Thèse de Paris, 1865; and M. Gayraud, Art. Crâne, Dict. Encyc. des Sci. Méd. 1879.

⁹ Jarjavay's Case, Compendium de Chir. pratique, t. iii. p. 100.

¹⁰ Balassa, Tumeur Emph. du Crâne. Revue Méd.-Chir., 1854.

¹¹ Voison, Du Pneumatocele du Crâne. Thèse de Paris, 1860.

normal skin. Its distinguishing feature is that it is resonant on percussion. By pressure, the tumor, when not too large, can be entirely emptied, this reduction being often accompanied by a hissing sound in the ear. In Chavance's case the membrana tympani had been ruptured, and on applying pressure to the tumor air issued from the ear with a whistling noise. In the frontal pneumatocele, a like hissing sound could be heard on auscultation when attempts were made to reduce the mass. Forceful expiratory efforts often increase the size of the tumor. Pneumatocele is painless and causes no inconvenience, although in a few cases it has been associated with pain in the part, some deafness, vertigo, and sickness. These symptoms are increased or induced by pressure on the tumor. In one case (Lloyd's) there was paralysis of the arm, and in the frontal tumor the sense of smell had been lost.

The *progress* of pneumatocele is very slow, being usually a matter of years. The tumor steadily increases in size, although in one case (Lloyd's) it trebled its dimensions in two days. It often attains large size, occupying one-half of the vault of the skull. Such large tumors are scarcely, if at all, affected by pressure. Pneumatocele shows no tendency to spontaneous cure, and at the same time a fatal issue has never occurred directly from this affection. The *prognosis*, therefore, is favorable.

Anatomy.—The air in these cases is always beneath the pericranium, and is derived from the mastoid cells or frontal sinus by spontaneous perforation of the bone covering those cavities. Chemical analysis shows this air to be somewhat modified in composition, its oxygen being diminished, its nitrogen and carbonic acid increased. These changes are similar to those noted in analyses of the gaseous matter obtained from cases of ordinary surgical emphysema. It is unnecessary to observe that the mastoid cells communicate with the middle ear, and the frontal sinus with the nasal cavity. The pericranium in these cases is of normal aspect, and the extent of the tumor is always found to be limited by the attachments of this membrane. The bone which underlies these tumors, and which is exposed when they are opened up, presents always a remarkable alteration. It is found to be extremely rough, and to present many irregular elevations and depressions; and so large are these bosses or elevations in some cases, that they can be felt through the integuments when the contents of the tumor have been removed by pressure. The cause of this remarkable change is unknown. It is coextensive with the separation of the pericranium; and it is stated that the bony irregularities disappear when the pericranium again becomes adherent to the skull, a condition that obtains in cases of cure. Apertures are observed in the exposed bone, and although there is no doubt that some at least of these communicate with the sinuses of the affected part, yet this communication has not been actually demonstrated in the only two cases which have been examined after death.¹ The evidence of this communication depends upon clinical observation, and is, I imagine, indisputable.

The *causes* of pneumatoceles are still most obscure. It is acknowledged that they are due to a spontaneous perforation of the bone covering an air-containing cell or sinus, but how that perforation is brought about is still unknown. Injury appears to be no factor in its production. In only one of the ten cases known to surgeons can a traumatism be fairly considered to have had any real concern in the etiology. It is probable, therefore, that the perforation is brought about either by a localized and progressive atrophy of the bone, or by the destructive action of caries sicca.² The atrophic

¹ Lecat, Recueil des Actes de la Soc. de Santé de Lyon, tome i. p. 31. 1798; and Fleury, Observat. de pneumat., Bull. de la Soc. de Chir., 2e série, tome viii. p. 520. Paris, 1867.

² Heineke, loc. cit., S. 14.

theory is supported by a comparison between this affection and the changes that occur sometimes in the skulls of old people whereby perforations in the vault are produced.¹ Hyrtl,² moreover, has shown that the air cavities of the skull may undergo great enlargement by the gradual atrophy of their walls; but as to the cause of that atrophy nothing is known. Many facts support the theory that the perforation is due to caries sicca. The pain and other symptoms often associated with the disease would bear upon this point, as would also the condition of the bone itself. It is maintained,³ however, that the irregularities on the surface of the bone are subsequent to the separation of the perieranium, but I would urge that this relation has not yet been satisfactorily demonstrated.

The *treatment* of pneumatocele should, in most cases, be merely palliative, and may consist of gentle and constant pressure upon the mass, maintained by a suitable pad and an elastic bandage, or, if on account of troublesome symptoms, or for other reasons, more active measures are called for, the tumor may be reduced, or if irreducible, emptied by a fine trocar, and then firm pressure kept up over the site of the tumor for a number of weeks. In Denonvillier's case, the mass was very much reduced in size in fifty days. Many of the recorded cases were treated by incision, a treatment that must be strongly condemned. For in each case so treated, severe suppuration followed, and in two cases led to a fatal issue—by pyæmia in Lecat's case, and by extension of the inflammation to the brain in that of Fleury's patient.

HÆMATOMA.—As far as the external soft parts of the head are concerned, collections of blood may be formed in three situations: 1. Above the aponeurosis, in the substance of the true scalp. (Hæmatomata in this situation are generally small and circumscribed.) 2. Below the aponeurosis, in the loose connective tissue that separates it from perieranium. (These blood collections are generally extensive and diffuse.) 3. Beneath the perieranium. It is to blood tumors only in this last situation that the term *cephalhæmatoma* is applied. Under the generic term of hæmatoma may also conveniently be considered certain remarkable blood tumors that communicate with the intracranial venous circulation.

Simple Hæmatomata of the Scalp.—Simple collections of blood situated either in the true scalp or in the connective tissue beneath its aponeurosis, require no especial mention in this place. They are the results of injury, and an account of the general history and treatment of such collections will be found elsewhere.

One word, however, may be said with regard to extensive blood collections beneath the aponeurosis in children. These may involve nearly the whole vault, being limited solely by the attachments of the aponeurosis, and may attain an immense size. So extensive may these blood tumors be, that they may simulate hydrocephalus;⁴ from which affection, however, they may readily be distinguished by their history, by the absence of the characteristic shape of the forehead, and by the fact that the normal skull may be felt beneath the collection of fluid. Such large extravasations are most frequent in cachectic children, and often follow upon apparently very trifling injuries.⁵

¹ Vide *infra*, Atrophy of Skull.

² Hyrtl, De la déhiscence spontanée de la route du tympan et des cellules mastoïdiennes. Comptes rendus de l'Acad. des Sciences, tome xxx, No. 10. 1858.

³ Gayraud, Art. "Crâne." Dict. Encycl. des Sc. Méd., p. 538. 1879.

⁴ Holmes, Art. Regional Surgery. System of Surgery, 2d ed., vol. v. p. 963.

⁵ See a remarkable case in a boy of eight years, reported by Dr. James Finlayson; the tumor was so large as to simulate hydrocephalus, and there was no direct history of injury. The case proved fatal. Glasgow Med. Journal, 1880, p. 190.

CEPHALHÆMATOMA.—This term is limited to blood tumors formed between the pericranium and the bone, and occurring in newly-born children. These tumors are very rare. In observations made at the Hôpital de la Charité de Marseille, Seux¹ met with only 19 cases of cephalhæmatoma in 5674 newly-born children—a proportion of about 1 in 298. Bouchacourt,² from the collected statistics of other observers, gives the proportion as 1 in 250 newly-born children.

Cephalhæmatoma is much more common in male than in female children, and is said to be somewhat more frequent in the children of primiparæ than in others.

Seat.—The great majority of these tumors are situated on the parietal bones, and more often on the right side than on the left. They generally occupy the posterior superior angle of the bone. Elsewhere they are very rare. A few have been met with over the occipital bone, still fewer over the frontal, and none on the temporal bone. There may be one, or even more than one, on each parietal.

Anatomy.—The pericranium inclosing the extravasated blood is quite unaltered, except under certain circumstances, to be hereafter mentioned. The subjacent bone usually presents a normal aspect, although in cases of long standing it may become rough by a deposit of new bone upon its surface.³ In some rare cases it may be thinned, and, still more rarely, perforated.⁴ The contained blood may be fluid, and coagulate on removal; but more usually it is found more or less coagulated, and of jelly-like consistence. Sometimes it appears to be inclosed in a kind of pseudo-membrane. Before it has existed long, and generally within a week, certain changes take place at the extreme periphery of the tumor, which finally result in the mass being encircled in an osseous ring or "*bourrelet*." This osseous circle is typical of cephalhæmatoma. It occupies precisely the angle formed at the spot where the pericranium actually leaves the bone, and as that surface of the long ring which looks towards the blood collection is perpendicular to the plane of the skull, it will be seen that this *bourrelet* will in transverse section present a triangular outline.⁵ The bony matter of the ring is easily separated from the subjacent bone, which then appears normal. Similar formations of bone are observed in rabbits subjected to experimental elevation of the pericranium.⁶ As the cephalhæmatoma subsides, the osseous circle disappears, and in time leaves not the least trace of its existence. In certain cases, more especially in those of old standing, a thin layer of bone forms beneath the separated pericranium, and a tumor so modified often crackles under the finger like tinsel.⁷

Causes.—Valleix,⁸ and also Paul Dubois,⁹ have shown that, in the newly-born, the external table of the skull is porous, vascular, incomplete, and partially absent. The diploic vessels, therefore, are almost exposed; and it is easy to understand that even a trifling pressure applied to the yielding head of an infant, during delivery, may cause the pericranium to glide upon the subjacent bone, and, by a slight injury to vascular connections, produce a hemorrhage. Bouchacourt's¹⁰ researches show that at the base of the common swellings of the head in the newly-born, a slight subpericranial hemor-

¹ Seux, Recherches sur les Maladies des Enfants Nouveaux-nés. Paris, 1863.

² A. Bouchacourt, Nouveau Dict. de Méd. et de Chir. Prat., Art. Céphalématome. 1873.

³ West, Diseases of Infancy and Childhood, 6th ed., p. 59. 1874.

⁴ Follin et Duplay, Traité de Path. Ext., tome iii. p. 556. 1869.

⁵ A good drawing to show this osseous ring is figured by Follin and Duplay, op. cit., p. 558.

⁶ Bouchacourt, loc. cit., p. 5.

⁷ This change is well described in South's edition of Chelius's "Surgery," vol. ii. p. 449.

⁸ Valleix, Clinique des Malades des Enfants Nouveaux nés, p. 494. Paris, 1839.

⁹ Dict. de Médecine, etc., 2e éd. (Dict. en 30), Art. Céphalématome.

¹⁰ Bouchacourt, loc. cit., p. 6.

rhage is almost invariably to be found. A little pressure of the head upon the pelvis of the mother, or, as some would urge, the contractions of the uterus itself upon the head, may provide all the force required to produce a cephalhæmatoma. It is well known that this blood tumor occurs in children delivered by the very easiest form of labor, and that it has been observed also in cases of breech or foot presentation. Some, therefore, insist on a spontaneous or even an intra-uterine cause for this affection. I think, however, that it may be safely ascribed to injury—however trifling—inflicted during birth.

Symptoms—Cephalhæmatoma is little noticed at birth, but usually appears within forty-eight hours. When first observed it is generally about the size of a hazelnut; it gradually increases, and in a few days may be the size of a chestnut. Some cephalhæmatomata have been as large as hens' eggs, and Chelius says that they may involve the whole parietal bone. The tumor is circumscribed, soft, elastic, slightly fluctuating, and painless. The skin over it is normal, or a trifle discolored, if some days have elapsed; or tense, if the tumor has grown quickly. The tumors are always precisely limited by the pericranium, and, therefore, never extend beyond a suture, a feature of value in diagnosis. In a few days a tolerably hard ring can be felt around the soft tumor. This is probably due to partial coagulation, and is soon replaced by a quite hard ring, which, as above stated, is actually osseous. Sometimes too the crackling on pressure, due to subpericranial ossification, can be appreciated. Having attained certain dimensions, the tumor begins to subside. As it becomes more flaccid, the bony circle becomes more distinct, and is the last component of the tumor to disappear.

These tumors do not pulsate, except in those very rare cases in which a neighboring artery gives some feeble impulse to the mass, or in which a communicating internal cephalhæmatoma exists.

In the *diagnosis* of cephalhæmatoma, the chief points are its time of appearing, its tendency to increase, its elastic character, its osseous ring, and the precision with which the tumor is limited to one bone.

The *prognosis* is most favorable. In the great majority of cases, spontaneous cure follows in from fifteen days to two months from the date of appearance of the tumor. In a few cases suppuration has followed, and in still less frequent instances, caries or necrosis of the subjacent bone is recorded.

The *treatment* of cephalhæmatoma simply consists in letting the tumor alone. Interference of any kind is useless, if not harmful. If, however, it should at any time become painful, or if it should persist for more than two months, and still appear soft, the mass may be aspirated, and firm pressure applied. Discutients, pressure, the seton, cautery, and incision, are simply mentioned to be condemned.

INTERNAL CEPHALHÆMATOMA.—This term has been applied to hemorrhages between the dura mater and the bone observed in the newly born. It is impossible to diagnose this condition during life, and it presents no practical interest. Sometimes, however, a hemorrhage in this situation may coincide with an external cephalhæmatoma, and not infrequently the two blood tumors have communicated through a fissure in the bone, whereby pulsation has been given to the superficial mass. Such tumors are, however, very rare, and, as a rule, soon end fatally. They may be mistaken for meningoceles, from which tumors they may be distinguished by the fact that they are small, flat, without pedicle, and quite opaque, and that they are usually situated on the parietal bone where meningoceles do not occur.

The "*céphalématome des femmes*" of French authors refers to a tumor said

to occur in the scalp of women and young girls, and to be associated with retarded menstruation.

BLOOD-TUMORS OF THE SCALP IN COMMUNICATION WITH THE INTRACRANIAL VENOUS CIRCULATION.¹—These tumors are very rare, and consist essentially of a collection of venous blood beneath the pericranium, communicating by an aperture in the bone with the superior longitudinal sinus. Communications with no other intracranial veins have been actually made out, although Dupont has endeavored to prove that in some cases the communication is with the diploic veins. The communication with the sinus may be either effected by an injury or spontaneous. Pott² gives an excellent example of the former mode of causation. A splinter of bone having been driven into the superior longitudinal sinus without laceration of the skin, a typical blood-tumor was the result. As to how the spontaneous perforation of the bone is effected, nothing certain is known. Many theories have been advanced, some urging that the perforation is the result of atrophy in a Pacchionian depression, others that it is due to bone-disease, and others that it is brought about by means of a varicose emissary vein. The blood is, in the first instance at least, beneath the pericranium; but in some cases it may come through that membrane and appear beneath the skin. If the case be due to injury, one crack or fissure in the bone will be found to maintain the abnormal communication; but in cases of spontaneous perforation many holes are generally found, some of them very minute. Apart from these apertures the bone as a rule presents a normal aspect. In some cases a slight peripheral ring of bone exists like that found in cephalhæmatoma.

Symptoms.—Most of the cases are met with in the frontal region, a few in the parietal, and very few, indeed, in the occipital region.³ In all instances they are about the line of the sinus. So little trouble do these tumors occasion, that they are generally discovered by accident. They are never large, being, as a rule, about the size of a chestnut; are round and soft; possess distinctly fluid contents; and are covered either by normal skin or by a thinned and purple integument. They are reducible by pressure, either wholly or in part, and, when reduced, the perforation in the skull may sometimes be detected, and a return of the mass prevented for a time by applying the finger to the bone. They can be increased in size by coughing, by stooping the head, and by compressing the internal jugular veins in the neck. In certain rare cases "a dull kind of pulsation" (as Pott expresses it) can be felt. A bruit is never present. These blood tumors show little tendency to increase, and less to undergo spontaneous cure. In a few instances they cause some pain and vertigo (increased by pressure), but as a rule they give no trouble.

The *prognosis*, therefore, is perfectly favorable as long as these tumors escape injury.

Diagnosis.—To diagnose these tumors from varices of the superficial veins, a ring of ivory or lead is made use of. This is placed on the head so as to encircle the tumor, and is pressed firmly down against the scalp. A simple varicose vein cannot be reduced in size while the ring is on, whereas its

¹ An excellent account is given of these tumors by Dupont (Thèse de Paris, 1858, No. 78), and also by Hermann Demme (Virchow's Archiv, Band xxii. H. 1, 2. 1861.); the latter author attempts to divide these tumors into three distinct categories. See also article "Crâne" by Dr. Gayraud, in the Dict. Encyclop. des Sc. Méd., p. 544. 1879. Dufour (Comptes Rend. de la Soc. de Biologie, 1e série, tome iii. p. 155. Paris, 1851), and Hutin (Mémoires de Méd. de Chir. et de Phar. Militaires, 2e série, tome xiv. Paris, 1854), record post-mortem examinations.

² The Chirurgical Works of Percival Pott, vol. i. p. 156. London, 1808.

³ See, however, cases by Flint (New England Journ. of Med., vol. ix. p. 112), and by J. W. Ogle (British and Foreign Med.-Chir. Review, vol. xxxvi. p. 212. 1865).

presence will not at all influence the reduction of the blood tumor. These collections may be distinguished from collections of pus, which, being situated both within and without the cranium, communicate through a hole in the bone, by the absence of any previous inflammation or evidence of bone-disease.

No *treatment* is needed. All that is required is that the tumor shall be protected by a well-fitting plate of gutta-percha or metal. Perhaps pressure may be tried. Any operative procedure would be almost unjustifiable, considering the immediate connection of the tumor with the interior of the cranium.

CYSTS OF THE SCALP.—The true cysts of the scalp include common sebaceous cysts, congenital or dermoid cysts, and serous cysts. With the common sebaceous cysts will also be considered, for convenience sake, *follicular ulcers of the scalp*, and *horns*.

I. THE COMMON SEBACEOUS OR FOLLICULAR CYST.—*Anatomy.*—These cysts form the very commonest tumors of the scalp, and are popularly known as “wens.” As regards their nature they may be classed as retention-cysts, being due, for the most part at least, to an accumulation of secretion in the sebaceous follicles of the skin. A large number of them show on their surface a black spot which represents the still patent orifice of the greatly distended follicle. Some, however, show no such orifice, and these have been considered to be derived from abortive follicles—from follicles imperfectly developed, and that probably have never contained a hair, and have never opened upon the skin. The cyst wall is generally distinct and well formed; at first thin and pliant, it may become in time thicker and more firm. It has a distinct lining of squamous epithelium, and it is important to note that between this lining epithelium and the epithelial contents there is no line of distinct demarcation.¹ The contents of the cysts vary. In what may be regarded as their most typical state, they consist of layers of soft, white, epidermic scales, that show evidence of softening about the centre of the mass. Such is the appearance in young cysts, but in long-standing tumors the nature of the contents varies considerably. They may be wholly pultaceous, or the centre may be pultaceous while the epidermic matter at the periphery has from pressure become so hard as to appear like a distinct, laminated, horny layer. In this way are formed what are incorrectly known as “thick-walled cysts:” the thickness of the wall is due to no changes in the thin wall or capsule, but simply to lamination of the contents. Portions of the horny matter which form the so-called “walls” of these cysts may be detached and lie loose among the softer contents, and such hard masses may sometimes be distinctly felt through the integument.² At other times the contents may be almost or quite fluid, and may even, according to Sir Prescott Hewett, become transparent. Or they may be discolored by admixture with blood, or may contain much cholesterolin (cholesteatoma). Lastly, the contents may become firm and putty-like, or cretaceous, and according to Heineke³ a peculiar ossification of the whole mass may be met with. This last observer says that calcification is not uncommon in the smaller cysts.

These tumors are situated primarily in the subdermic tissues between the skin and the aponeurosis of the scalp muscle, and have at first but a loose

¹ Cornil et Ranvier, Manuel d'Histologie Pathologique, 2e éd., tome i. p. 350. 1881.

² Hewett, Sebaceous Tumors of the Cranial Region. St. George's Hosp. Reports, vol. iv. p. 96. 1869.

³ Loc. cit., S. 37. He believes the ossification to take place through a connective-tissue formation that appears among the epithelium.

connection with adjacent parts, so that they may be almost made to roll under the skin. They soon become more adherent, especially if inflamed at any time. The skin covering them, although at first normal, becomes thinned, pinkish, and more or less bald. And, on the other hand, progressing deeply, the cyst, if large, often comes in contact with the skull. It is now generally allowed that this form of sebaceous cyst does not affect the subjacent bone, and never causes perforation.¹ The very utmost change which it may produce is to form a trifling depression on the surface of the skull, and this even is denied by some.

Of the *etiology* of these cysts, little is known. They are often distinctly hereditary, are more common in women than in men, and usually appear first in youth and early adult life. They are much more frequent upon the hairy scalp than upon the forehead and temples, and often *appear* to be produced by injuries or by erysipelas of the scalp. When on the scalp they are often multiple. Prof. Gross alludes to the case of a man who had some two hundred of these tumors on his scalp.²

Progress and Termination.—The rate of growth is usually very slow, and generally a matter of years. It varies, however, considerably. At any period the cyst may remain stationary for an indefinite time. As a rule, these tumors do not attain a great size. The largest, however, are met with on the scalp, and usually at the posterior part of the scalp, and here they may attain enormous dimensions. On the brow they seldom, if ever, attain a large size. The skin may rupture spontaneously and give exit to the cyst, although this is more usually the result of injury. At any time the cyst may suppurate. Such suppuration is usually most tedious, a sinus resulting that for an indefinite time discharges a thin pus mixed with the fetid contents of the cyst. Extensive ulceration may follow, and a so-called “fungating or follicular ulcer” be produced.³ From a peculiar growth of epithelium from its exposed lining membrane, “horns” may be formed.⁴ Cases of entire absorption or disappearance of sebaceous cysts have been recorded. I had under my care recently a woman in whom this had occurred. The cyst was the size of a large marble.

The *diagnosis* is easy, and may be gathered from the preceding remarks. “The chief points to be looked to, in addition to those that are common to all cysts, are their immediately subcutaneous situation; their regular, smooth, round, or oval form, which may in some instances be made to change by pressure when the contents are of a soft substance that may be moulded into various shapes; the easy mobility; the dark central point; the hereditary origin; the slow growth; the healthiness of the immediately surrounding parts; the absence of change in them from the pulse or respiration, and of head symptoms when they are pressed.”⁵

Treatment.—The only treatment is that by excision. As a rule the cysts on the scalp shell out very readily. Sometimes, if small, the cyst can be removed entire with very little dissecting. If any difficulty be experienced, the tumor may be transfixed, and the cyst then forcibly pulled out with forceps. It is essential that every portion of the cyst-wall should be removed. On no account should an attempt be made to remove a sebaceous cyst while in a state of acute inflammation. If it be inflamed, a simple puncture should be made into the cyst, a poultice applied, and further operation left until the

¹ See an interesting discussion before the Surgical Society of Ireland, April 6, 1866, opened by Dr. B. Wills Richardson.

² System of Surgery, 5th ed., vol. ii. p. 114. Philadelphia, 1877.

³ See page 127.

⁴ See page 127.

⁵ Holmes's System of Surgery, 2d ed., vol. i. p. 517. Art. “Tumors,” by Sir James Paget and Mr. C. H. Moore.

more urgent inflammatory symptoms have subsided. If the cyst be very large, it may be necessary to remove some of the redundant skin. If, for any reason, a portion of the cyst-wall should be left behind after attempted excision, the epithelial surface should be well rubbed with solid nitrate of silver to destroy the secreting elements, and the wound should be dressed for a while from the bottom. Considering the frequency of the operation of excision, and the little after-attention which the wound generally receives, it is a proceeding no more frequently followed by ill consequences than the infliction of any other simple wound.

Follicular or Fungating Ulcer.—This term is given to an ulcer sometimes formed by the breaking down of one of these sebaceous cysts. The skin over the cyst usually gives way in several places, so that many discharging holes are formed, and the destructive process proceeds until a large ulcer is formed with these characters: its edge is raised, everted, rugged, prominent, and very irregular; its base is occupied by a foul, fungating mass; it is of considerable depth; and it spreads by advancement of the ulcerative action. The fungous mass represents the remains of the sebaceous contents mixed with a crowd of very exuberant granulations that spring from the lining membrane of the cyst, now irritated by the presence of too much effete matter. The sebaceous matter does not itself actually become vascularized, as some less recent authors have urged, but the persistent irritation produced by the morbid changes in the exposed cyst-wall perpetuates the ulcerative process, and leads to a spreading of the sore. Cock gives some excellent drawings of this condition.¹ This peculiar ulcerative process appears to be most apt to affect cysts of some standing, and especially those occurring in old persons, the disease being rarely met with before fifty. Considering the usual age of the patients, and the general features of the ulcer, it will be seen that this might readily be taken for epithelioma.² Any difficulties on this point may, however, be cleared up by noticing in the non-malignant ulcer the history of the case, the presence possibly of unaltered sebaceous matter, the absence of a hard infiltration of the periphery, as in epithelioma, the fact that the disease progresses with little bleeding and less pain, while the health remains good, and the glands are unaffected. It must be remembered, however, that such ulcers as these may take on a genuine epitheliomatous action.³ Some of the reported cases are cases rather of fungating sarcoma of the scalp.⁴ In regard to *treatment*, the surface of the ulcer having been well cleaned by a poultice, the remaining portion of the cyst may be excised. The operation is, however, often tedious and bloody, and a better plan, therefore, is to apply the actual cautery lightly, but thoroughly, to the whole remaining surface of the cyst, when a slough separates, and the ulcer generally heals kindly.

Horns.—These strange excrescences are developed from the interior of a sebaceous cyst that has been opened up, either by rupture, or, more usually, by inflammation. They have the appearance, and almost the density, of actual horn, and are formed of heaped-up sebaceous matter that has become dry and indurated. Fresh matter is constantly being formed at the base of the excrescence, and so it increases in length and bulk. Sir Erasmus Wilson has given a full account of these growths.⁵ Out of 90 collected cases, 44 were in females and 39 in males, the sex of the remainder being unknown; in

¹ A few Remarks on a Peculiar Follicular Disease. Guy's Hosp. Reports, 2d s. vol. viii. p. 51. 1853.

² See a celebrated case of M. Chassaignac's, in Bull. de la Soc. de Chir., tomes i. et ii.

³ See case reported by Dr. Péan, Leçons de Clinique Chirurg., p. 532. 1876.

⁴ Goodhart, Follicular Disease of the Scalp. Guy's Hosp. Reports, 3d s. vol. xviii. p. 221. 1873.

⁵ Transactions of the Royal Medical and Chirurgical Society, vol. xxvii. 1843.

no less than 48 out of the 90 cases the horn grew from the head, and 38 of these scalp cases occurred in patients past middle life. The horn is generally single, somewhat pointed, and curved. In the New York Medical Repository, for 1820, is recorded the case of a man from whose forehead grew a horn that had three branches and was fourteen inches in circumference. In many of the recorded cases the horns have been four, five, six, and eight inches in length. If accidentally torn off they are apt to be re-formed. Their growth is slow, and they are only troublesome mechanically, and from an æsthetic point of view. As regards *treatment*, the mass should be removed, and every trace of the cyst or secreting surface at its base most scrupulously excised.

II. CONGENITAL DERMOID CYSTS.—These, as regards their *anatomy*, closely resemble the common cyst. They have thinner and more perfect walls, as a rule, and are lined by a perfect epidermis, with, very often, small growing hairs. The contents are commonly spermaceti-like, or more oily or turbid, or even serous and clear, and generally present some fine loose hairs. Bryant reports a case in which the cyst contained “a complete ball of hair.”¹ The contents are seldom offensive. These tumors have a tendency to indent or even perforate the subjacent bone. Many such cases are recorded.² As a rule, a round depression has been found on the bone, at the bottom of which has been a small hole leading to the cranial cavity. The precise cause and significance of this perforation are unknown.

Site.—The congenital cyst is usually found about the outer angle of the orbit, next in frequency on the front of the frontal bone, and very rarely, over the other bones of the vault. Cases are recorded of cysts imbedded deeply in or beneath the temporal muscle. These growths are (primarily at least) beneath the scalp muscle, and are, as a rule, closely adherent to the pericranium.

Progress.—These tumors grow very slowly, seldom exceeding the general rate of growth of the body. They rarely attain a greater diameter than two-thirds of an inch.³

As to the *diagnosis* of these round, tense, and typically cystic bodies, nothing need be said. They are compared with other congenital growths elsewhere. Two remarkable cases are reported of dermoid cysts mistaken for meningocele. Both cases occurred in female children, respectively three and eight months old. In each case the tumor was small, translucent, without pulse, and irreducible, and located close to the anterior fontanelle. In one case,⁴ tapping gave exit to a clear fluid; in the other,⁵ the cyst was situated over a congenital hole in the skull, and had pulsated in earlier infancy. Both tumors proved to be dermoid cysts, and to have no communication with the cranial cavity.

The *treatment* involves questions of difficulty. These cysts are often difficult to excise, especially when about the orbit. They appear superficial, and yet are found to extend often to a dangerous depth, and if any cyst wall be left behind an intractable suppuration follows. In other parts their removal may not be difficult. If a cyst about the orbit therefore is small, not increasing, and a source of no inconvenience, it may be well to let it alone. If excision is demanded for any reason, it must be performed with the utmost care and patience. It would, in most cases, be unwise to operate on those

¹ Manual for the Practice of Surgery, 2d ed., vol. i. p. 104.

² Athol Johnson, Lectures on the Surgery of Childhood, p. 15. London, 1860.

³ Sir James Paget and Mr. C. H. Moore, loc. cit., p. 514.

⁴ Giraudeau, Comptes rendus de la Soc. de Biologie, 4e série, tome iii. p. 77. 1866.

⁵ Henry Arnott, Trans. of Path. Soc. of London, vol. xxv. p. 228. 1874.

cysts that have certainly perforated the skull. Mr. Athol Johnson¹ reports a fatal case of this kind. Sir Prescott Hewett,² on the other hand, reports a case in which a dermoid cyst, after causing no trouble for twenty years, grew, perforated the orbital roof, and caused death. An unusual case of this kind, however, should hardly lead us to advocate an early removal in all instances.

III. SEROUS CYSTS are extremely rare. They are either (1) congenital, or (2) formed from extravasated blood, or (3) formed from a meningocele whose connection with the cranial cavity has been cut off. Those that are congenital are, as a rule, small, multi-cystic, situate in the occipital region, and located either above or beneath the aponeurosis.³ They contain clear serum, too rich in albumen to be mistaken for cerebro-spinal fluid. Billroth gives an example of a serous cyst over the occiput as large almost as the patient's head. The subjacent bone was quite sound.

The history of the case would, in each of the three forms, greatly assist the diagnosis. The treatment of such tumors requires no special notice.

VASCULAR TUMORS OF THE SCALP.⁴—*Nævus*; *Telangeiectasis*; *Simple or Plexiform Angioma*; *Cavernous Angioma*; *Erectile Tumor*. The various forms or varieties of vascular growth included under these different terms are all met with on the scalp, and may be conveniently considered under the common and generic term *Nævus*. Nævi occur more frequently on the head than on any other part of the body, and, according to Heineke, arterial angiomata may be said to belong exclusively to the head.⁵ Nævi may occur anywhere on the scalp, but are most common about the anterior fontanelle, the orbit, and the temple. They are much less common about the occiput. As Virchow has pointed out, angiomata are often located on the sites of the branchial clefts—the “*tumeurs érectiles fissurales*” of French authors. The undue frequency of nævi about the head may perhaps be due to the dependent posture of the head in fetal life, and to injury inflicted during birth. The superficial or capillary nævus is more commonly met with on the head than is the deeper or venous nævus, or cavernous tumor, the latter being generally limited to the hairy part of the scalp, while the former may occur anywhere.

All these growths are, for the most part, congenital, and appear at or soon after birth. The superficial nævus is not met with at an earlier period than are the deeper growths—the subcutaneous or venous nævus, or cavernous angioma. There is little limit in the size of these tumors; some may be enormous, and may occupy wide tracts of the head. As Chelius⁶ observes, some of the largest and most rapid growths have been met with about the ear. Mr. Barwell⁷ remarks that nævus over the mastoid process may “by growth in size and complexity become a cirroid aneurism.” A growing nævus under the hairy scalp causes baldness, the hairs falling out as the atrophy of the skin progresses. These tumors may extend in depth and involve the galea, the pericranium, and even the bone, which in such cases becomes porous from the number of its vessels.⁸ They may, on the other hand, undergo spontaneous cure, especially after an inflammation of the soft parts. Such a cure usually occurs in the superficial, cutaneous nævi, and is much less frequent in the more deeply seated tumors, or in the cavernous angiomata.

Diagnosis.—These blood-tumors may be conveniently divided into 1, the cu-

¹ Loc. cit., p. 15.

² Loc. cit., St. George's Hosp. Reports, p. 93.

³ Ward, Trans. of Path. Soc. of London, vol. xi. p. 268. 1860.

⁴ See Vol. II., p. 803.

⁵ Loc. cit., S. 22.

⁶ Chelius's Surgery, translated by South, vol. ii. p. 381.

⁷ Lancet, vol. i. p. 642. 1875.

⁸ Dr. Robert Lee (Med.-Chir. Trans., vol. xxii. p. 300. 1829) gives the case of a monster with extensive nevroid growth of the scalp that involved also the dura mater, the intervening bone being absent. He gives references to cases of somewhat like character.

taneous; 2, the subcutaneous; 3, the mixed. 1. The cutaneous angiomas are composed of capillary vessels arranged in an intricate plexus, and considerably altered in structure. These form the simplest kind of plexiform angiomas, and appear as bright-red or claret spots upon the skin, their surface being commonly a little raised and granular. 2. These tumors are situated in the subcutaneous tissues, although they may extend beyond them. They are venous in structure, as a rule, the vessels being arranged in a plexus (plexiform angioma), or after the manner of erectile tissue (cavernous angioma, erectile tumor); they form distinct tumors, covered with purplish and thinned integument, are smooth, somewhat lobulated, doughy, and elastic, and are capable of being more or less emptied on pressure. They often increase also on violent respiratory efforts. If the tissue has much of the arterial element, the mass may feebly pulsate, but such a growth would more aptly be considered with cirroid aneurism. 3. The mixed form is a complication of the two preceding forms, the skin being more or less involved. The tumors may ulcerate and give rise to severe hemorrhage.

Treatment.—If the tumor be quite stationary and small, and cause no gross disfigurement, the advisability of operation may be questioned. With regard to the many different modes of treating nævus I will say nothing, but will refer merely to those measures that appear most applicable in the scalp. Pressure with a disk of lead or a small coin, secured by an elastic band, has answered well in some small nævi that involved the tissues to no great depth.¹ It may at least be tried. With regard to operative measures, I would urge that most nævi of the scalp can be well treated either by the actual cautery or the simple ligature, with in a few cases a recourse to excision. Nævi up to the size of a shilling can, as a rule, be well treated by a light application of the thermo-cautery, if quite cutaneous, and by a more prolonged application when they extend beyond the skin. This treatment is at the time more painful than that by nitric acid (which, however, is only applicable to superficial growths), but the pain passes off much sooner, and the result is much more certain, one application being in the great majority of cases all that is required. I have used the thermo-cautery in a very large number of cases, and without a single bad result. If one has to deal with a very extensive superficial nævus, involving only the skin, the same method may be adopted, and it is then better to treat portions only of the diseased area at a time, commencing at the periphery. Large venous nævi and cavernous tumors of the width of a shilling and larger can be well treated by the simple ligature. This method is especially suited to prominent tumors covered with thin and diseased integument. I have found the following mode of using the ligature most efficacious. The mass is ligated in the usual way in two segments, a harelip pin having been passed through its base, and the threads at right angles to the pin. It is important to lightly incise the skin at the base of the growth, in the line that will be followed by the ligature. This lessens the amount of pain and the duration of the strangulating process, and in young children much diminishes the liability to convulsions. The pin is not removed. In four days the whole of the ligatured mass should be sliced off level with the surrounding skin, by passing the knife beneath the harelip pin; some bleeding follows, which is immediately checked by light pressure with cotton-wool. The advantages of this subsequent excision are these: The duration of the treatment is very greatly diminished, the risks of ill effects much lessened, and a much cleaner and finer scar is produced. If the skin over the mass be sound, ligation will hardly be so applicable, owing

¹ See *Lancet*, vol. ii., 1867, article on Nævi, by Mr. Thomas Smith: and *Surgical Diseases of Children*, by Mr. Cooper Forster, p. 223. London, 1860.

to the tension of the scalp; excision may then be practised, bleeding during the operation being checked by a ring of lead, or by strips of the same metal, pressed firmly against the scalp. The subcutaneous ligature appears to be peculiarly unsuited to the scalp. Nævi larger than can be treated by ligature may be excised, if all other means have failed, or treated with puncture by the actual cautery. By the latter method a fine thermo-cautery point is thrust in various directions into the substance of the nævus through the same skin puncture. Little reaction, as a rule, follows, but the mass begins to shrink. The treatment may require to be repeated five or six times in a large mass. I have found it most successful in very large nævi. Much has been said as to the treatment of nævi over the anterior fontanelle. All operative measures applied to such nævi, while the fontanelle is still open, are attended with much risk, and should never be undertaken, unless under urgent reasons, until the opening has closed.¹ The nævus, especially if deeply seated, will often much diminish in size when such closure has taken place.

Michaud² records a case of nævus of the scalp that communicated by small veins with the superior longitudinal sinus. A communication of a like character probably occurs more frequently than is at present supposed, and may account for some of the rapid deaths with brain symptoms that have followed in a few instances the treatment of even the most simple nævi in this situation.

CIRROID ANEURISM.—*Aneurism by Anastomosis; Racemose Aneurism; Arterial Varix.*—These terms are applied to tumors made up of the dilated and varicose arteries of a given area, and their smaller branches. When the disease affects the larger arterial trunks, the name cirroid aneurism is used, and when it extends into the capillary networks, it is known as racemose or anastomotic aneurism; the term arterial varix has been limited by some authors to the affection as it involves single large arteries.

This disease is almost limited to the head, being very rare elsewhere. It occurs usually in connection with the temporal, posterior auricular, and occipital arteries. As it increases, it may extend either towards the capillaries or towards the main trunk, and, in the latter case, may involve even the common carotid. It may extend beyond the middle line, and involve the other side of the head. The skin over the mass is usually thin and wrinkled, but may be thickened. The subjacent bone is often grooved by the dilated vessels, and Verneuil³ gives a case in which the bone was actually perforated.

These tumors are sometimes due to injury, but more commonly arise from the dilatation of the afferent arteries of a simple angioma, which latter growth can often be detected in the centre of the arterial swelling. They occur most usually in young adults.

Progress.—These growths are apt to increase to some extent, and may attain enormous size. They may, however, at any time become stationary, or even undergo spontaneous cure, an event that has in most cases been subsequent to a fever. The mass may ulcerate, or the skin become so thinned that rupture occurs, followed by fatal hemorrhage.

The *symptoms* of these tumors have been fully described elsewhere,⁴ and it is here only needful to allude to their leading features: an irregular, varicose mass with visibly dilated arteries about its periphery, pulsation, a blowing bruit, a fine thrill felt by the fingers, reducibility of the mass on pressure, and an altered state of the integument, which is usually found thinned and discolored.

¹ Mr. Erichsen expresses an opposite opinion; *Science and Art of Surgery*, vol. i. p. 717. 1872.

² *L'Union Médicale*, p. 254. 1859.

³ *Varices artérielles du Cuir chevelu.* Thèse.

⁴ See Vol. II., pages 804 *et seq.*

Treatment.—These vascular tumors are most difficult to cure, and are very intractable to any treatment. Should the cirroid aneurism show no tendency to increase, give no great inconvenience to the patient, and threaten no immediate danger, it had better be let alone, being merely protected by a suitable cap or disk. With regard to operative measures, the following may be placed among those that have been tried and discarded as of little or no value: compression, ligature of the separate vessels entering the mass, and ligature of the external carotid of the same side. Ligature of the common carotid has had but indifferent success. Heineke¹ states that only three cases of cure have resulted in thirty-two instances in which this operation has been performed. [Dr. Wyeth's statistics, though not quite so unfavorable, also show that this operation should be reserved for exceptional cases.²] The treatment to be advised in these cases is mainly directed against the mass itself. If the cirroid aneurism be quite small, it may be ligatured *en masse*. This has been successful, but ligature of larger tumors, and the practice of partial ligature, or ligature of successive portions, is not to be advised. Galvano-puncture also may be tried, and has been successful. It can at least do little harm. If these measures fail or be inadmissible, the best results are obtained from excision of the whole mass. This operation, to be successful, should be preceded by ligature of the common carotid artery, or by the adoption of some local means to arrest hemorrhage. This object is best attained by applying acupressure to the entire periphery of the tumor by a number of needles. After the mass has been excised, the needles should be withdrawn one by one and the separate vessels ligatured as exposed. Of all operations for the relief of cirroid aneurism of the scalp, that of excision has certainly met with the greatest amount of success.

ANEURISM OF THE ARTERIES OF THE SCALP.—Aneurism is very rarely met with on the scalp, and in all the recorded cases appears to have been of traumatic origin. The tumor is most commonly situated on the temporal artery, though cases are also recorded of aneurism of the posterior auricular and occipital arteries. These aneurisms seldom attain a great size, few being larger than a hazel-nut, and they give, as a rule, little or no trouble. They are apt to hollow out the bone, and the skin over them may become so thinned as to lead to rupture of the sac. The tumor being very superficial, the symptoms are most characteristic. As a rule, they are readily cured. In some cases, compression has effected this end,³ and this simple treatment may at least be tried in any instance. If this fail, the artery should be ligatured on either side of the aneurism, or the "old operation" performed.

ARTERIO-VEINous ANEURISMS are very rare on the scalp. Heineke could only find records of five cases. Of these, four concerned the temporal artery and vein, and one the posterior auricular vessels. In every instance there had been an injury. These tumors do not tend to attain great size, and they give but little trouble. If small, not increasing, and attended by no real inconvenience, they may be let alone. If for any reason an operation is demanded, the most successful consists in excising the entire mass, and ligaturing all the vessels concerned. In one case, Chelius⁴ thought fit to tie the common carotid for an arterio-venous aneurism of the temple. Benefit followed, but it was only temporary.

¹ Loc. cit., S. 30.

² [See Dr. Wyeth's table of 73 cases (82 operations) in Vol. II., pp. 808 *et seq.*]

³ See case by M. Mirault, *Gazette des Hôpitaux*, No. 147. 1860.

⁴ Op. cit., vol. ii. p. 271.

• MALFORMATIONS OF THE SKULL.

These malformations are numerous, varied, and for the most part congenital. The majority of them are of no interest to the practical surgeon, and many, as, for instance, anencephaly, exencephaly, etc., are incompatible with existence. Cephalocele will be treated of hereafter. Among the acquired deformities, it is only necessary to allude to those purposely produced by certain nations¹ (such as the Caribs) by pressure upon the skull in infancy; to the "diamond-shaped head"² produced by compression at birth; and to the "obliquité du crâne par propulsion unilatérale"³ induced by allowing very young infants to lie always upon the same side of the body. These are at least of some slight interest in being not quite unpreventable. Of much more interest, however, are certain *congenital holes and fissures* in the skull that appear to be of no infrequent occurrence, and to persist often throughout the life of the individual. They are all due to imperfect developments.⁴ The occipital bone may present persistent fissures, the remains of those that occur in the developing bone; or a larger or smaller part of the superior angle may exist as a separate bone, the "*os épactale*," whose line of union with the main bone may be mistaken for a fracture. The parietal bone is frequently the seat of certain holes that may persist during life. These parietal holes are generally two in number, and are symmetrically disposed, one on either bone, at or about its most prominent point. Their usual diameter is from one-third to one millimetre. They may, however, be much larger,⁵ and in the Musée du Val-de-grace, there is a skull with parietal holes that measure three centimetres. These holes may be mistaken for fractures, and are apt to seriously complicate diagnosis when a superficial growth happens to be located over one of them. Mr. Thomas Smith⁶ records a case in a child aged four years, in whose skull were found the following congenital holes: one on the right side of the occipital bone, three inches by two inches, and one on either parietal, measuring respectively two inches by two inches, and two inches by one inch. Over one of these holes an abscess had formed, which pulsated synchronously with the pulse.

MENINGOCELE; ENCEPHALOCELE; HYDRENCEPHALOCELE.—These terms are applied to certain tumors that consist essentially of a protrusion of some part of the cranial contents through an aperture in the skull. They are congenital, and are observed either at or soon after birth. Reference will be made hereafter to certain rare tumors known as acquired cephaloceles. These must be kept distinct from those now under consideration. The contents of these tumors vary, and it is according to the nature of these contents that they are classified and named. When the tumor contains a protrusion of the meninges only, the term *meningocele* is used; when a protrusion of brain, the term *encephalocele*; and when the mass is formed by a portion of brain, greatly distended with fluid from a dropsical ventricle, it receives the name of *hydrencephalocele*.

¹ For an account of such like deformities, see M. Topinard's "Anthropology."

² Dr. Ogier Ward, Path. Trans. London, vol. iii. p. 225.

³ M. Guéniot, Bull. de la Soc. de Chir., tome x. p. 383. 1866.

⁴ An excellent account of these mal-developments is given by M. S. Pozzi, Art. Crâne (Développement), Dict. Encycl. des Sc. Méd., p. 467. 1879.

⁵ See Depressions in the Parietal Bones, by Professor Humphry, Journ. Anat. and Phys., vol. vii. p. 136. 1874.

⁶ Path. Soc. Trans. London, vol. xvi. p. 224. For account of Aplasia Cranii (imperfect ossification of skull), see, also, Heineke, loc. cit., S. 43.

*Anatomy.*¹—These various tumors are of a round or pyriform outline, and present as a rule a uniform surface. Sometimes, however, sharp fissures or depressions appear upon the surface, giving the mass a lobed appearance, suggestive of its division into two or more parts. In size they vary greatly: the smallest may be the size of a little nut, and the largest may exceed the dimensions of the patient's head. They usually present a distinct neck, and are often actually pedunculated. As a rule, they are covered by normal scalp, more or less deficient in hair, according to the size and tenseness of the tumor; but in other cases the integuments may be much atrophied, or red and vascular, or raw like a granulating surface, or represented solely by a scar-like tissue. The sac is composed of dura mater lined by the arachnoid, and in some cases presents irregular sacculi and partitions, although in the majority of instances its interior is perfectly smooth. The hole in the skull through which the mass protrudes, varies greatly in size and shape, and usually presents a clean and even edge. If much brain has escaped from the cranium, microcephaly will exist, although it may be somewhat modified in its conspicuousness by the hydrocephalus that is very often present in these cases. Scoliosis or unequal development of the skull is also common in severe instances; and other congenital deformities, such as spina bifida, hare-lip, cleft palate, talipes, and umbilical ruptures, not infrequently coexist.

Of these tumors, *meningocoele* is the rarest. Indeed, some authors question its existence.² It simply consists of a protrusion of the dura mater and arachnoid, and may be regarded as a limited hydrocs of the arachnoid sac. Heineke regards it as the remains of an encephalocoele, the protruded portion of brain having returned into the skull. Others, however, consider meningocele as the commencement of a brain protrusion. There is no doubt that this tumor is extremely rare, and that the bulk of the cases reported as meningoceles are really hydrencephalocoeles. *Encephalocoele* is not so uncommon, and consists of a hernia of a portion of the brain, that is usually connected with the cerebral mass by a narrower portion or pedicle. There may be no fluid in the sac, but if any is present, it is entirely external to the brain substance. *Hydrencephalocoele*, by far the gravest of these tumors, is, unfortunately, the variety most usually met with. The piece of brain protruded in these cases is found to be distended by fluid from a ventricle. Indeed, the condition is that of an extreme but limited ventricular hydrocephalus. The cavity in the protrusion is connected with the affected ventricle by a contracted channel that may be very narrow, the hernial portion being as it were a diverticulum from the ventricle. The protruded portion of brain may be so distended as to be represented by a mere film of cerebral matter, and in many cases all traces of it are lost except about the neck of the tumor. The corresponding ventricle is always distended, such distension being, however, as a rule, infinitely less in degree than that found in the protruded part. This is generally so distended that all trace of convolution on the surface is lost. In addition to the internal collection, some fluid may also be found in the sac, quite external to the brain.

Situation.—By far the most common site for these tumors is the occipital region, and next the fronto-nasal region. From the base of the skull, and from the parietal and temporal regions, these protrusions are rare. In 93 collected cases, 68 were about the occiput, 16 in the fronto-nasal region, and 9 about the base.³

¹ For a full account of the anatomy of these affections, see an article by Sir Prescott Hewett, in St. George's Hospital Reports, vol. vi. p. 117. 1873. Also monograph by M. Spring, Mém. de l'Académ. de Belgique, tome iii. Brussels, 1853.

² L.-A. de Saint-Germain, Art. Encéphalocèle, Nouveau Dict. de Méd. et de Chirg. Pratique, p. 195. 1870.

³ Houel, Arch. Gén. de Méd., 5e série, tome xiv. pp. 409, 569. 1859.

(1) *Occipital Region*.—The hole in the occipital bone through which the mass protrudes, is in or near the middle line, and may be above or below the protuberance. If above, it may blend with the front fontanelle, and if below, with the foramen magnum, or in addition with the cleft for a spina bifida. The tumors in this situation are apt to be large and pendulous, of pyriform shape, and pedunculated. Chauvier records a case, occurring in this locality, in which the mass hung from the back of the head to the loins.¹ In some cases the whole or the greater part of the occipital bone may be absent; or, if present, it may show a complete median cleft. Occipital encephaloceles may contain portions of the posterior cerebral lobes or of the cerebellum. A hydrancephalocele in the upper part of the bone would probably contain part of the posterior lobe or lobes of the cerebrum, and the distended posterior cornu of the lateral ventricle; in the lower part of the bone, the whole or part of the cerebellum with a dropsical fourth ventricle. In large masses, both the cerebrum and cerebellum may be concerned.

(2) *Frontal Region*.—The tumors usually appear at or about the root of the nose, the protrusion leaving the skull between the cribriform plate and the frontal bone, and appearing externally between the frontal and nasal bones. In a few cases the protrusion has been between the halves of the frontal bone,² and in still fewer in the lateral parts of the bone.³ The anterior lobes are the parts of the brain involved, with, in cases of hydrancephalocele, the anterior cornua of the lateral ventricles. Tumors in this site are usually smaller than those on the occiput, and present few, if any, of those surface divisions so common in the tumors of the latter situation. The skin covering them is also very frequently red and vascular, so that these frontal tumors have often been mistaken for vascular growths. Enormous tumors have, however, been met with in this locality,⁴ but they are rare when compared with the frequent occurrence of such large growths over the occiput.

Sides and Base of the Skull.—Congenital protrusions have occurred at various parts of the sides of the skull, chiefly about the lateral fontanelles or in the lines of sutures. Mr. Hutchinson⁵ quotes a case occurring at the anterior fontanelle, and Dr. Steavenson⁶ a median protrusion through a cleft extending from the posterior fontanelle to the alveolar process of the jaw. At the base of the skull, the hole has been found between the ethmoid and sphenoid bones, or between the sphenoid and its greater wing, or through the sphenoid itself. Tumors issuing from such apertures have appeared in the pharynx or in the mouth, have even projected beyond the mouth, have occupied the orbit and displaced the globe, or have escaped by the sphenomaxillary fissure. Hydrancephaloceles about the base have been composed of the temporo-sphenoidal lobes distended by the inferior cornua or the base of the third ventricle, or by the infundibulum and pituitary body pushed down by fluid distension occurring in the last-named ventricle.

Into the *etiology* of these affections, the limits of this article will not allow me to enter. A vast number of theories have been advanced, the most generally received being one that explains the protrusion by the existence of an intra-uterine hydrocephalus. The whole matter is well discussed by Heineke.⁷

¹ Quoted by Sir Prescott Hewett, loc. cit., p. 119.

² See a case, for instance, reported by Mr. Christopher Heath. Trans. of Path. Soc. London, vol. xvi. p. 10. 1865.

³ Case by Robt. Adams, Dublin Journ. of Med. and Chem. Science, vol. ii. 1833. Other cases are quoted.

⁴ See a case reported by Niemeyer (De Hernia Cerebri Congenita. Halæ, 1833.), in which the tumor reached the clavicle.

⁵ Illustrations of Clinical Surgery, vol. ii. Plate 46.

⁶ Trans. Clinical Soc. Lond., April, 1881.

⁷ Pitha und Billroth's Handbuch, Band iii. Chirurgische Krankheiten des Kopfes.

Symptoms and Diagnosis.—All these tumors have to a greater or less extent the following general characteristics. They are congenital, are most common over the occiput or root of the nose, and are fixed at their bases. They form roundish, elastic tumors, with, as a rule, some evidence of fluid contents; have often a pulsation synchronous with the beat of the heart;¹ are increased in size by forced expiratory efforts; and are more or less reducible, such reduction being often followed by brain symptoms (sense of pain or restlessness, vomiting, convulsions, or stupor, with, in some cases, strabismus and temporary loss of muscular power). If pendulous, the very weight of the tumor may cause such symptoms, all trouble passing off when the mass is elevated. In some cases the hole in the skull may be felt, and often the head is microcephalic, or shows unequal development. The separate symptoms of each special form of tumor, and the points in which they differ from one another, and which constitute the elements of their differential diagnosis, may be best exhibited in the form of a table.

	Size and surface.	Coverings.	Pedicle.	Fluctuation.	Translucency.	Pulsation.	Effects of forced expirations.	Reducibility.	Pressure effects.	Condition of skull, etc.
MENINGOCELE.	Small, especially at first. — Surface smooth.	As a rule normal; may be thinn'd.	As a rule pedunculated.	Most distinct.	Perfectly translucent throughout.	Rarely present.	Render the tumor more tense.	Always reducible, as a rule completely.	Symptoms produced only on strong pressure.	As a rule normal.
ENCEPHALOCELE.	As a rule small, seldom exceeds size of small orange. — Surface smooth.	As a rule normal; may be unduly vascular.	Has a wide base; is rarely pedunculated.	Absent (mass soft and yielding) unless there be fluid in sac.	Opaque, unless there be fluid in sac, when mass may be translucent at apex.	Distinct pulsation.	Produce distinct enlargement.	Reducible, but not always completely.	Symptoms readily induced.	As a rule normal.
HYDROENCEPHALOCELE.	Generally large, often of great size, and pendulous. — Surface often irregularly divided or lobed.	Often thin, excoriated or wrinkled.	As a rule distinctly pedunculated.	Distinct.	Often translucent, but only at the most prominent and dependent parts.	Very seldom pulsate.	Produce only a very slight effect.	As a rule are but little affected in size by pressure, and are irreducible.	Symptoms seldom induced.	Microcephalic, or scoliosis. May be paralysis of limbs or talipes.

These tumors have been mistaken for sebaceous cysts,² for abscesses,³ for vascular growths,⁴ for cephalhæmatomata,⁵ for serous cysts,⁶ and for nasal polypi.⁷ In the last instance (Dr. Lichtenberg's case), a large bluish tumor projected some way out of the mouth. Its pedicle was traced through a cleft palate up to the roof of the nose. It was ligatured. Death ensued in

¹ Sir Prescott Hewett says that pulsation is absent in the majority of cases. Loc. cit., p. 134.

² Holmes's Surgical Treatment of Children's Diseases, page 67. 1868. See also Prescott Hewett, loc. cit., pp. 134.

³ Athol Johnson, Lectures on the Surgery of Childhood, p. 11. 1860.

⁴ Th. Zdzienski, Encephalocoeles Congenitæ Casus rarior. Dorpat, 1857. Paul Dubois, quoted by Sir P. Hewett, loc. cit. M. Guersant, Bull. de la Soc. de Chir. de Paris, tome i. p. 66. Jon. Hutchinson, Illus. of Clin. Surgery, vol. i. page 1.

⁵ Observations on Surgical Diseases of Head and Neck. (Ferrand.) Sydenham Soc., p. 125. 1848.

⁶ Case of M. Chassaignac's, quoted by M. L.-A. de St. Germain. Nouveau Dict., loc. cit.; also Holmes, op. cit., p. 66.

⁷ Lichtenberg, Trans. Path. Soc. Lond., vol. xviii. page 250.

four days. It was then found to be a cerebral protrusion that had issued through a hole in front of the sella turcica.

Progress and Prognosis.—The majority of infants who are born alive with these deformities do not long survive their birth, but die during the first few days or sometimes weeks of life. The prognosis is worse in hydrancephalocele than in the other tumors. In hydrancephalocele, indeed, the prognosis is absolutely bad; in many cases the condition of the brain is incompatible with any but the briefest existence, and in other instances the mass rapidly enlarges, and in time bursts, death occurring from collapse or convulsions, or acute meningitis. Very few indeed live even a few weeks. Sir Prescott Hewett¹ and Laurence² give cases in which patients survived some months, but these instances must be regarded as quite exceptional. In meningocele the prognosis is a little better. As a rule, however, the tumor increases rapidly, bursts and causes death, and this event usually occurs soon after birth. Some increase much more slowly, and months may elapse before a rupture takes place. Others, having attained a certain size, remain stationary for an indefinite period, while in still more fortunate instances the cavity of the tumor becomes cut off from the cranial cavity, and the tumor becomes harmless.³ Many cases therefore of cure of meningocele have been recorded. It is in encephalocele that the prognosis is the most favorable. Although a great number die soon after birth, yet the early mortality is not as great as in the other forms of tumor. In some cases there may be fluid in the sac, and this, by increasing, may cause rupture, and death from meningitis, etc. But commonly the tumors attain no great size, and very commonly remain stationary. Some patients thus affected may therefore reach puberty, but they often are idiotic, or suffer from paralysis or some other gross nerve lesion. Patients with encephalocele have, however, survived many years and enjoyed perfect health. Such cases have been met with in patients aged 15,⁴ 20,⁵ and 33⁶ years, and between these ages no small number of cases have been recorded. As regards the situation of these congenital tumors (regarded generally), the prognosis is most unfavorable for those about the occiput, not so grave for those in the frontal region, and least serious for those upon the vertex.

Treatment.—Operation in these cases is only justifiable under *one* condition, and that is when rupture of the tumor is threatening. Otherwise the mass should be simply protected, and as firm pressure applied as the patient can bear without inconvenience.

(1) *Meningocele.*—If rupture be threatening, the sac may be emptied by the trocar, and pressure applied. If it refill, it should be tapped again, and the repeated tapping may result in cure.⁷ If, however, the sac refill in a shorter time after each tapping, and the fluid become dull, injections of iodine may be used. It must be owned, however, that this latter treatment has met with no success, although in two cases⁸ the tumor remained stationary after the injection. Mr. Holmes uses a solution of one part of tincture of iodine to two parts of water; he injects two drachms of this solution, and allows it to

¹ Loc. cit., p. 132.

² Med.-Chir. Trans., vol. xxxix. p. 307. 1856.

³ See cases by Mr. Solly, Med.-Chir. Trans., vol. xl. p. 19, and Mr. Hutchinson's *Illustr. of Clin. Surg.*, vol. ii. p. 25. Dr. Carrington has recorded a case of so-called meningocele that became apparently quite harmless. *Lancet*, vol. ii. p. 894. 1880.

⁴ Prescott Hewett, loc. cit., p. 138.

⁵ Robert Adams, loc. cit.

⁶ Guyenot, *Mémoires de l'Académie de Chirurgie*, tome i. p. 863. See other cases in J. Z. Laurence's paper.

⁷ Case recorded by Mr. James West; *Lancet*, vol. vii. p. 552. 1875.

⁸ Cases recorded by Sir James Paget, *Path. Trans.*, vol. xvi. p. 12, and by Mr. Holmes, *St. George's Hosp. Reports*, vol. i. p. 35. 1866.

remain. In a case where the coverings of the sac were sloughing, Mr. Anandale¹ ligatured the mass; a cure followed.

(2) *Encephalocele*.—If there be fluid in the sac, by the increase of which perforation is threatened, the case may be treated as one of meningocele, as far only as repeatedappings are concerned. If the case be one of simple encephalocele, gentle pressure should be tried in reducible cases, and protection adopted in those that are irreducible. In one case, at least, pressure has induced cure.²

(3) *Hydrencephalocele*.—These tumors can only be treated by protecting them from injury or undue pressure. All operations, save puncture to prevent a threatened rupture, would be impracticable. Several cases are recorded where meningoceles, and even encephaloceles, have been cut into by mistake, and a cure of the tumor resulted. Such cases should, however, be regarded rather as warnings than as examples for practice.

DISEASES OF THE SKULL, ETC.

PERICRANITIS AND CRANITIS. (*Osteo-periostitis*.)—The term *pericranitis* is applied to inflammations of the pericranium, the term *cranitis* to an inflammation of the bones of the skull. From a pathological and a clinical point of view, however, it is both difficult and inadvisable to consider these two affections apart from one another. In the great majority of instances of pericranitis, the subjacent bone is already inflamed, and the mischief in the membrane is secondary to the mischief in the bone. Primary pericranitis is an affection by no means of common occurrence, and inasmuch as inflammations of the bone and of the membrane on its outer surface are so intimately associated, it is more convenient to consider them together under the title of *osteo-periostitis*.

It must be remembered that the pericranium does not hold those important relations to the bone it covers that exist between the periosteum and the bones of other parts of the body. The principal blood-supply of the skull bones is derived from the vessels supported by the dura mater. These bones are, therefore, to a great extent, independent of the support afforded by the pericranium, a fact illustrated by those cases in which little or no bone mischief has followed upon extensive separation of this outer membrane. Osteo-periostitis of the skull may be acute or chronic.

I. ACUTE OSTEO-PERIOSTITIS.—*Etiology*.—The commonest cause of this form is injury, especially a lesion that directly injures or exposes the bone, or that is associated with impacted foreign substances of any kind.

It not infrequently follows from wounds, the discharges of which have become retained or offensive. It may be due to the spreading of a like mischief from neighboring parts, from the bones of the face, orbit, or ear. In some rare cases, acute osteo-periostitis has been set up by the invasion of the bone or periosteum by a spreading ulcer of the scalp.

It has been asserted that this affection may be of purely spontaneous origin, and may be due to exposure to cold, to rheumatism, to gout, and to syphilis; but the facts brought forward in support of these assertions are, it must be confessed, somewhat meagre.

Pathology.—The pericranium becomes congested, softened, and thickened, and dissected from the subjacent bone by a varying amount of inflam-

¹ Edinburgh Medical Journal, April, 1867.

² Case recorded by M. Ferrand, loc. cit., p. 125.

matory material that has been poured out between them. The inflammatory products are apt to soon become purulent, and an acute periosteal abscess to be thus formed. The diploic tissue is congested and invaded with an inflammatory exudation that is also very apt to become purulent. At an early stage phlebitis of the diploic veins is prone to occur, and these vessels will be found blocked with thrombi, that in severe cases are breaking down in suppuration. As not infrequent complications may be noted inflammation of the dura mater or of the other membranes of the brain, collections of pus between the dura mater and the bone, thrombosis of the cerebral sinuses, and in rare instances abscess of the brain.

The inflammatory action may extend towards the surface and result in a suppurative inflammation of the sub-aponeurotic connective tissue, or of the scalp itself. If a fatal termination does not ensue at an early date, necrosis of the affected bone is a common result of this malady.¹

The *symptoms* of this disease are somewhat obscure, and are apt to be masked by those more serious complications with which it is so often attended. The patient complains at first of a fixed pain at some part of the skull, which pain persists, is frequently intense, and usually much worse at night. Rigors occur, associated with fever, headache, vomiting, and in some cases delirium. A painful, tense, and deep-seated tumor appears at the affected spot, if the skin be intact, and in the centre of this mass fluctuation in time becomes evident. There is often some œdema of the scalp, especially in the later stages. If the tumor be incised, pus escapes, and the subjacent bone is found to be bare. Cerebral symptoms are apt to supervene, or, if the case assume a more favorable aspect, necrosis of the affected bone may be diagnosed. From diffuse inflammation of the scalp this malady may be distinguished by the early appearance of œdema in the former affection, the somewhat less intense character of the pain and general symptoms, and the fact that the swelling is diffuse and apt to spread widely, whereas in osteo-periostitis it remains limited to the bone involved, and does not extend beyond the lines of the sutures.

The *prognosis* is unfavorable. Death occurs in the majority of cases, being caused usually either by cerebral complications or by pyæmia. The early and marked implication of the veins of the part especially favors this latter termination. In rare instances resolution may occur. In other cases a necrosis of the inflamed bone is brought about. This necrosis may be of a slight and superficial character, but more usually it involves the entire thickness of the affected bone.

Treatment.—Cases of acute osteo-periostitis of the skull must be treated on the general principles advocated in the treatment of like conditions elsewhere. An early incision is imperative, and a free exit must be given to all purulent collections. An ice bag should be kept constantly applied to the head. If the affection can be recognized early, and its nature clearly demonstrated, it may be advisable to trephine the external table and open up the diploë. The early occurrence, however, of diploic phlebitis would negative to some extent the usefulness of this measure.

II. CHRONIC OSTEO-PERIOSTITIS may in rare instances follow upon the acute form of the disease, but in the great majority of cases is due to syphilis.

The *pathology* of this affection (considering only the more common form) is treated of in other portions of the work. In this place it is only necessary to allude to the few points that follow: The inflammatory process involved

¹ A good account of this affection, illustrated by excellent plates, will be found in Mr. Jonathan Hutchinson's *Illustrations of Clinical Surgery*, vol. i. London, 1878.

in the usual form of chronic osteo-periostitis is that known as the gummatous; and, indeed, the disease is described by some authors under the title "osteitis gummosa cranii." The gummatous change may commence either in the bone itself, in the deeper layers of the pericranium, or in the dura mater. Most usually it commences as a gummatous pericranitis. The frontal and parietal bones are those most commonly attacked, but the disease may involve many bones, and is in some cases very extensive. If the affection commence on the surface of the bone, the pericranium becomes lifted off by the material of the gumma, and an external tumor is perceptible that is known as a syphilitic node.

If the bone be affected, it is found to be penetrated by gummatous matter, and the parts involved often become converted into a soft lardaceous mass. This soft material may be absorbed, and in this way a loss of substance in the bone becomes obvious; and if the whole thickness of the bone has been involved, a perforation results. These defects and perforations are not filled up by new bone, but are covered in by a fibrous cicatrix derived from the fibrous investments of the bone at the affected part. Many parts of the bone may be attacked at once, and so many little pits and perforations may be formed in a comparatively small area. To this form of the malady Virchow has given the name of dry syphilitic caries. About these bone defects, osteophytic plates are apt to form upon the surface of the skull, and are derived from ossification of the inflammatory or gummatous material.

Speaking generally, the syphilitic deposit (as it is often called) may (1) be absorbed, (2) may ossify, or (3) may break down into suppuration. An example of absorption is afforded in dry syphilitic caries, and in the entire disappearance of large subpericranial nodes. Ossification is not uncommon. By its agency, the affected bone is rendered denser, thicker, and more compact. If the pericranial deposits ossify, hard, irregular elevations of bone, of variable size, may be formed, constituting one form of exostosis. In the same way, from ossification of material thrown out between the dura mater and the bone, exostoses or growths from the inner surface of the skull may be produced. The rarest mode of ending for the syphilitic material is by suppuration. Necrosis may follow from this disease, of which sequence more will be said presently.

The *symptoms* are often somewhat indefinite, and the nature of the disease can be more often suspected than positively diagnosed, especially when the morbid process is deeply seated in the bone. The patient, the subject of tertiary syphilis, complains of slight but fixed pain in some part of the head. This pain is worse at night, and is influenced not a little by the state of the weather. There will generally be some tenderness on pressure. If the pericranium be involved, a deep-seated, hard swelling very slowly forms—a syphilitic node. This swelling holds a very chronic course, and may in time disappear, or become bony, or break down into pus. If there be no surface node, the diagnosis is more difficult, and no cases are more hard to interpret than are those in which the irritation of a projecting syphilitic mass from the interior of the skull has caused brain symptoms. The amenability of the disorder to antisiphilitic treatment is of much value in the diagnosis.

The *treatment* of syphilitic osteo-periostitis of the skull does not materially differ from the treatment adopted in like bone disease elsewhere. Iodide of potassium should be freely and diligently given, and every measure adopted that may improve the patient's general health. In the majority of cases, the administration of mercury at the same time will be found of considerable advantage, unless there be something in the patient's condition to contraindicate the drug. The inflamed part should be protected, and no application is needed beyond that used for this protection. If there be certain

evidence of suppuration, an early incision down to the bone will be called for. The prognosis in these cases is on the whole favorable.

CARIES OF THE SKULL.—Caries is frequently met with in the skull bones, although the structure of these bones predisposes them rather to necrosis.

Etiology.—The commonest cause of caries in this locality is undoubtedly tertiary syphilis, the disease following upon a chronic syphilitic osteo-periostitis. Many cases are due to scrofula, and in a few rare instances, the cause is injury. Caries from injury is extremely rare in the healthy, the usual degenerative change, if any, being necrosis. If caries should follow upon traumatism, it will then be usually quite limited and restricted to the external table. Some conspicuous exceptions have, however, been recorded. Sir Prescott Hewett¹ cites a case of caries of the frontal and both parietal bones, and of part of the occipital bone, that followed from a simple blow on the head. Abercrombie² records a remarkable case where very extensive caries of the *internal* table occurred after a by no means severe fall upon the head, and a few other exceptional cases of a like nature have been reported. Caries may also extend from the upper cervical vertebræ to the adjacent bones of the base of the skull, and Sir P. Hewett asserts that caries in this latter situation may likewise be due to extension of inflammation from extensive syphilitic ulcers of the pharynx. Caries of certain parts of the temporal bone is usually subsequent to suppurative catarrh of the tympanum.

Pathology.—Caries may attack any part of the skull, although it has a special predilection for certain localities. It is most often met with on the frontal bone, particularly at its anterior part, or about its union with the parietals. Next in order of frequency may be placed the mastoid process, and then, perhaps, the occipital bone. Although the disease is usually limited, it may be, on the other hand, very extensive, and may involve, indeed, almost the entire skull. The external table is more frequently implicated than is the internal table; or, if they are both involved, then still will the change be usually more extensive in the outer plate. Mr. Gray³ has recorded a curious case of caries, fatal through brain complications, where the disease was limited to a small carious spot on the sella turcica. Caries may commence in either the external or internal table, or in the diploë; or it may appear simultaneously in more than one of those parts. Into an account of the minute changes in caries of the skull, it is unnecessary here to enter. Such changes are identical with those observed in caries elsewhere, and have already been fully dealt with in a previous article. Some few special points, however, require notice. Caries of the skull in the dried specimen presents the familiar aspect of caries in other parts. The diseased surface is eroded and worm-eaten, and the limits of the affected district very irregular. The depth to which the destructive action may penetrate from the surface varies greatly. It may extend only through the outer table, or may involve more or less of the diploë, or may perforate to the internal skull-plate. The carious action is usually more destructive in the diploic tissue than in either the external or internal table; the result being that some undermining of those tables about a carious hole is very common. If the disease has spread from without inwards, and caused perforation of the inner plate, the perforations are apt to be small and numerous, rather than solitary and extensive. Exceptions, however, are by no means uncommon.

¹ Lectures on Injuries and Diseases of the Head. Med. Times and Gazette, vol. i. p. 230. 1855.

² Pathological and Practical Researches on Diseases of the Brain and Spinal Cord, p. 188. Edinburgh, 1845.

³ Trans. Path. Soc. London, vol. ii. p. 19.

Caries due to *syphilis* may assume one of two aspects—dry caries (so called) and ulcerating caries. The former variety has already been alluded to in speaking of osteo-periostitis. A skull, the subject of this affection, usually exhibits over a more or less extensive surface a number of holes in the outer plate. These holes are clean cut and irregular, and vary in size from that of a mere pin's-point to that of a three-penny piece, or larger. The edges of these holes are, as a rule, very thin, and much undermined by a more extensive loss of tissue in the diploë. The internal table may be thinned and perforated in a few places. In some rare cases there is a slight formation of coarse, new bone about the carious spots, and in other instances the edges of a large hole in the external table will be found rounded off, and the diploë beneath converted into dense compact bone, that may fairly be spoken of as an osseous cicatrix. In the recent specimen, the depressions, holes, and cavities in the bone are filled in with gummatus material. In the ulcerating form of caries, suppuration has taken place, and the disease presents the aspect of ordinary caries, except for the fact that very often the mischief so spreads as to form an annular or semi-annular outline. This tendency of the edge to become rounded is identical with a like tendency in tertiary syphilitic ulcers of the skin. This form of caries usually begins with the formation of a sub-pericranial gumma; and in cases where the internal table is first attacked, with a gummatus deposit between the dura mater and the bone. As compared with other varieties of caries, that due to syphilis is more apt to be extensive.

In *scrofulous* or *tuberculous* caries, we have to deal with a true tubercular process in the bone. The affection commonly commences by changes in the deeper layers of the pericranium, and probably at the same time in the outer surface of the bone. The pericranium, thickened and congested, is lifted off by a collection of inflammatory material beneath it. Thus an external tumor is formed that is sometimes known as a scrofulous node, or gumma. In process of time, if this tumor be incised, a quantity of curdy, ill-conditioned pus will escape, and the subjacent bone be found carious. In like manner the mischief may commence on the inner aspect of the cranium. In some instances the disease would appear to commence in the diploë, and when so commencing it may lead to the most typical forms of what is known as *perforating tuberculosis of the skull*.

In this disease, the affected bone is found converted into a more or less cheesy material, and more or less extensively destroyed. The inner and outer tables are both perforated. At the seat of these perforations, the dura mater and pericranium will be found more or less separated from the subjacent bone by inflammatory or purulent matters. In time an external tumor forms. This, on being incised, allows of an escape of pus that has been pent up beneath the pericranium, and the nature of the affection becomes obvious.¹

Scrofulous caries is usually of limited extent, but some few cases are recorded in which it has involved large portions of the skull. Mr. Cesar Hawkins, for example, describes a case where the right parietal bone, the right half of the occipital, the squamous and mastoid portions of the right temporal, the great wing of the sphenoid, and a large part of the frontal, were affected with scrofulous caries on both surfaces.² The disease in this case was rapid and soon fatal.

Symptoms.—The course of caries is usually slow and deliberate. In *caries of the outer table*, a part of the skull becomes a little tender, and the seat

¹ For a full account of Perforating Tuberculosis, see a paper by R. Volkmann, Centralblatt für Chirurgie, 1880, No. 1.

² Med.-Chir. Trans., vol. xxxix. page 285. 1856.

perhaps of a fixed pain that is worse at night. In time, a small, hard, deeply seated tumor appears at this spot. This enlarges and softens. On being incised, pus escapes, and carious bone can be felt with the probe.

Caries of the inner table may give rise to the most misleading symptoms. Its certain recognition is almost impossible. There will probably be fixed headache, perhaps some tenderness of the skull over the painful part, and then possibly head symptoms of various kinds—vertigo, convulsions, partial paralysis, delirium, etc. Indeed, the symptoms of caries in this situation are rather those of the brain mischief induced by the disease. If the dura mater be much separated from the bone by pus, there will probably be symptoms of compression. In *perforating caries* the evidences are a little more precise. After a period marked by some local pain and tenderness, and possibly by some vague cerebral symptoms, a tumor forms externally, which increases, and in time fluctuates. It will then be found that this tumor may be more or less reduced by pressure, and such reduction may cause temporary brain symptoms. The size of the mass also may be affected by respiration. On incision, much pus escapes, the discharge of which is rendered more free on forced expiration. The bone being now bared, a perforation of both tables may be observed.

The *diagnosis of syphilitic caries* depends to a great extent upon the history of the case, the evidences of tertiary syphilis, and the beneficial effects of antisyphilitic remedies. *Dry syphilitic caries* may be marked by almost a total absence of symptoms. A skull showing extensive disease of this nature was exhibited by Dr. Norman Moore at the Pathological Society of London. The whole vault of the skull was affected, but during life the patient had exhibited no symptoms of bone disease of any kind; the only fact noted about the head being that at one part of the scalp there was a little "eczema."¹

In most cases, however, there is pain in the cranial bones that increases at night, tenderness of the skull, some œdema possibly of the scalp, and in some instances slight evidences of brain disturbance. Of the other varieties of caries no especial notice is required.

Prognosis.—The progress of the disease is slow, and may last months and often years, especially when it depends upon some constitutional defect.

Death may occur from simple exhaustion, in cases of extensive caries, but, as a rule, the fatal issue depends upon some intra-cranial mischief, and less frequently upon pyæmia. The depth to which the caries extends, and the degree to which it involves the inner table, are therefore matters of more gravity as regards prognosis than is the simple extension of the disease upon the surface. The usual intra-cranial lesions are thrombosis of the sinuses of the dura mater (especially apt to occur when the diploë is involved), meningitis of the convexity, and abscess of the brain. In some cases, fatal compression may be caused by a collection of pus between the dura mater and the bone, and in several instances epilepsy has followed upon the bone disease. In caries of the mastoid and petrous bones, fatal hemorrhage has occurred from the internal carotid artery, from the internal jugular vein, and from one of the adjacent sinuses, these vessels having been opened up by an ulcerative process.

Treatment.—When the disease depends upon syphilis or struma, the appropriate constitutional remedies are required. In any case the health should be supported, and freedom, if possible, from all mental excitement advised. Collections of pus should be immediately evacuated, and free exit given to all discharges. In most cases, and in those especially in which the exter-

¹ See Lancet, Feb. 5, 1881.

nal plate only is involved, no operative treatment is required, it being only needful to aid repair by general measures. If the caries extend deeply into the bone, and be still spreading, a cautious use of the gouge may be advised; but in no case should either the actual cautery or liquid caustics of any kind be used. In certain cases, where pus is pent up either in the substance of the bone itself, or between the bone and the dura mater, the use of the trephine is to be recommended. In caries of the mastoid process, for example, an early application of the trephine will often relieve the most distressing symptoms and arrest the progress of the disease (for a while, at least), by the evacuation of pus situated deeply in the bone. In cases of so-called perforating tuberculosis, also, where pus is retained between the dura mater and the bone, or in the substance of the diploë, great benefit may attend the application of the trephine to the diseased area.¹ The ancient treatment of recklessly applying the trephine at many points around a carious spot is strongly to be condemned. Mr. Bryant² has recorded a case in which he trephined out a piece of carious bone in a patient who had become epileptic after the appearance of the disease, and who was suffering from hemiplegia. Considerable improvement followed upon the operation, but it was only temporary.

NECROSIS OF THE SKULL.—*Etiology.*—Necrosis may follow upon injuries of all kinds, especially upon fractures, where pieces of bone have been more or less entirely separated from the skull, and thus deprived of their blood supply. It may follow also upon simple contusions of the head, and in such cases it is probably due to some lesion of the bloodvessels nourishing the bone. There has been perhaps an extravasation of blood in the diploë, with some damage to the diploic tissue, or an extravasation has separated the dura mater from the bone, or a like separation has occurred in the pericranium. As the blood supply of the cranial bones is mainly derived from the dura mater, damage to that membrane is more effective in producing necrosis than is a corresponding lesion of the pericranium. Necrosis may also follow upon burns, or upon injuries of the parts from corrosive substances. Necrosis may terminate acute or chronic osteo-periostitis. It may be due to scrofula, and, in individuals with this diathesis, it is especially apt to occur after the eruptive fevers. But if one excepts that slight form of superficial necrosis (exfoliation) which is common after certain injuries, then certainly it is to syphilis that one must look for the most common cause of skull necrosis. According to some authors, nine-tenths of all cases of necrosis of the cranium can be ascribed to the tertiary form of this disease. Heineke³ quotes a remarkable case of necrosis of the contiguous parts of the frontal and parietal bones and great wing of the sphenoid, that occurred in a patient aged nineteen, after typhus fever. At the autopsy, it was found that the middle meningeal artery was blocked by a thrombus.

Pathology.—The seat of necrosis varies considerably. When due to injury, it may of course be in any bone, but the idiopathic forms are especially apt to attack the frontal and parietal bones, and are rarely met with in the occipital. Great variety is also seen in the extent of the disease. The necrotic action may involve the entire thickness of the bone, or may implicate only the external or the internal table. Its most frequent seat is in the external table, whereas necrosis of the inner plate only is extremely rare. When the whole thickness of the skull bone is necrosed, the outer table will usually be found to be more extensively involved than the inner table; or, in many

¹ R. Volkmann (loc. cit.) has performed this operation in four cases of perforating tuberculosis with good results.

² Medical Times and Gazette, vol. ii. page 158, 1860.

³ Loc. cit., S. 65.

instances, the destruction will be found equal on the two surfaces. Cases occasionally occur in which the whole thickness of the skull is lost at one place, and one table only at another. The necrosis is usually limited in extent. When the outer table alone is involved, the disease usually takes the form of exfoliation of bone, and sometimes the pieces of bone thus separated are so small as to be almost imperceptible. This is common after scalp wounds associated with a considerable surface of bared bone. Many cases are, however, recorded of very extensive necrosis. One of the most frequently quoted cases of extensive disease is the case given by Saviard, where the whole vault of the skull became necrosed subsequent to an injury to the head. As this case is one of great importance and interest, I quote in full Saviard's account of the patient:—

“ Une pauvre malheureuse sortit de l'Hôtel Dieu au mois d'Oct. 1688, après avoir été malade pendant plus de deux ans, en suite d'une playe à la tête qu'elle s'était faite en tombant, pour avoir bu du vin avec excès. La partie supérieure de l'os coronal, les deux pariétaux entiers et une grande portion de l'os occipital s'étant decouvert dans la suite du traitement, s'exfolièrent dans toute leur épaisseur et se séparèrent en même temps : de sorte que cette exfoliation ressemblait au dessus d'une tête que l'on aurait sciée et séparée du reste du crâne. L'on voïoit, à l'endroit d'où ces os étaient sortés, le battement de la dure-mère qui n'était couvert que d'une pellicule fort amincée.”¹

Norris² gives a case in which considerable portions of the parietal and temporal bones were lost, together with a great part of the frontal and occipital bones. The disease followed upon a fall on the head. A somewhat similar case is recorded by Drummond,³ where an equally extensive necrosis followed upon a scalp wound. South⁴ describes the case of a woman, who, in nine years, lost the greater part of both parietals, and some parts of the temporal, parietal, and occipital bones, from a necrosis that was supposed to be of syphilitic origin.

The mode of separation of the sequestrum is the same as that observed in necrosis elsewhere, and indeed the only pathological feature special to skull necrosis is the absence of any new bone formation. There is no invagination of the dead piece of bone, and no fresh osseous production formed to fill up the deficiency caused by its removal. If the external table alone separates, granulations spring up from the exposed, subjacent bone; these form a fibrous tissue which—with assistance from the pericranium—fills up the defect on the surface. If the whole thickness of a skull bone be involved in the sequestrum, granulations spring up from the adjacent bone, from the pericranium, and from the dura mater, and together form a mass of fibrous tissue that more or less perfectly fills up the void. The rough edges about the gap become rounded off and shelving, but beyond this show no reparative changes. In some cases of syphilitic disease, however, a slight amount of new bone may be formed around the sequestrum, so as to retain it as a watch-glass is retained, or, in the absence of such a definite formation, feeble growths of porous bone may be sometimes observed on the outer table in the vicinity of the necrosis, and such deposits often assume an annular outline.⁵ It is important to note that necrosis is not limited by sutures, and, indeed, often involves the contiguous parts of two or more bones at the same time.

In the matter of *symptoms* and *diagnosis*, nothing need be added to the

¹ Recueil d'Observ. Chirurg., p. 836. 1762.

² Trans. Med. Soc. Lond., vol. i. p. 168. 1810. Skull in Museum of Royal College of Surgeons.

³ Med.-Chir. Trans., vol. xxxiv. p. 103. 1851. A wax model of the patient's head is preserved at the Hadlar Hospital, at Portsmouth.

⁴ Chelius's Surgery, ed. by South, vol. i. p. 699. 1847.

⁵ Cornil et Ranvier, Manuel d'Histologie Pathologique, p. 405. 1881.

information given elsewhere. As may be supposed, special symptoms may arise, due to implication of neighboring nerve-structures. Sir James Paget, for example, has recorded a remarkable case of great atrophy of the right half of the tongue consequent upon necrosis of the occiput after injury. The mischief had evidently implicated the hypoglossal nerve in its passage through the diseased bone. On the removal of the sequestrum, the tongue rapidly regained its normal condition.¹

Prognosis.—In slight necrosis involving only the external table, a cure, as a rule, results after no very protracted period. When the disease, however, is more extensive, and when the whole thickness of the bone is involved, the course may be very chronic, and often extends over months and years. Some of the most severe cases have ended in cure without a bad symptom, but as long as the sequestrum remains unseparated there is considerable risk to the patient. Death may occur from exhaustion, as in Norris's case quoted above, but more usually it is due to meningitis, or to suppurative thrombosis of some of the cranial sinuses, or to compression of the brain by pus between the dura mater and the bone, or to pyæmic infection. The probability of cerebral mischief in any case is difficult to estimate. It is most common after necrosis in the mastoid process, and least common after like mischief in the frontal region. It has occurred in cases of most insignificant bone-disease on the one hand, and has been absent in cases where the dura mater has been freely exposed to a considerable extent. Speaking without the guidance of any actual statistics, cerebral troubles would appear to be more frequent after syphilitic necrosis than after the traumatic form of the disease.

Treatment.—Collections of pus should be immediately evacuated, and free exit given to all discharges. Superficial necrosis of the outer table may be practically left to itself, or the process of exfoliation may be aided by a cautious application of sulphuric acid. Loose sequestra should be removed as soon as possible, and, if the necrosed piece be too large for convenient removal through reasonable incisions, it may be so trephined as to allow of its being extracted in segments. Trephining also may be resorted to in those rare cases in which compression of the brain is being caused by a collection of pus between the dura mater and the bone. After the removal of the sequestrum, every precaution should be taken to protect the part from injury, while, at the same time, the wound is kept scrupulously clean.

The knowledge that the dura mater is exposed in any case, would appear to me an argument in favor of early removal of the sequestrum, rather than an excuse for leaving it in situ for a while, as some have vaguely advised.

HYPERTROPHY OF THE SKULL.—Under the simple term "hypertrophy," or the vaguer title "hyperostosis cranii," several distinct and different forms of morbid change in the cranial bones have been described. It is no matter of surprise, therefore, that this subject has been involved in considerable confusion. Under the above title, we may, I think, recognize at least *four* different forms of bone change. I do not maintain that these various forms represent of necessity different pathological processes: That may or may not be the case. I would only point out that a casual collection of so-called "hypertrophied skulls" would (if numerically large enough) present such distinct and constant varieties as to enable us to classify them under the four following heads: 1. Simple hypertrophy, general or local. 2. General "concentric hyperostosis." 3. "Osteo-porosis," in its various forms, the "diffuse excentric hyperostosis" of some authors. 4. "Leontiasis ossium," or "limited excentric hyperostosis." This medley of terms is the natural result of grouping

¹ Trans. of Clinical Soc., vol. ii. p. 238.

different morbid appearances under a common head. I will now deal with these four aspects of disease in detail.

1. Under this heading are classed *simple hypertrophies*, using that term in its purest sense. Of general, true hypertrophy of the skull, I know only one example. It is in the Museum of the Royal College of Surgeons. This skull is hypertrophied in every part. In structure the bones appear quite normal; the hypertrophy is uniform and accurately symmetrical, every bone and every point of a bone being in all parts evenly increased in size; the base is as much affected as the vault; all parts, therefore, of the cranium, bear to one another their normal relations, and, indeed, the only feature is pathological exaggeration. Of the cause of this condition nothing is known. It is a true hypertrophy of normal bone. Examples of local, true hypertrophy are common enough. The enlargement of certain parts of the skull, especially of the frontal bones, consequent upon atrophy of the brain, may be placed under this head.¹ In some of these cases, the increase in thickness of the bone appears to be mainly effected by the inner table. In other instances—which can hardly be called true hypertrophies—there is a deposit of new bone upon the internal plate, thus causing much thickening. The instances of thickening of the skull bones after the subsidence of hydrocephalus are also, as a rule, instances of this last-mentioned condition.

2. In so-called *general concentric hyperostosis* there is no alteration in the form of the skull, and no increase in the thickness of the component bones. There is, however, a great condensation of bone tissue, so that the diploë becomes as compact as the tables that inclose it, and the skull on section presents an uniform, ivory-like aspect. The sutures are generally obliterated. Thus are formed those compact, heavy skulls, of which specimens exist in most pathological museums. The change is usually limited to the vault, but is then evenly distributed over its entire area. It is most common in advanced life. Of its cause, nothing is known, and its recognition is impossible during life. This condition of the bone is often ascribed to a blow, or to syphilis, but I am aware of no evidence to support such suggestions. Chronic cranitis often causes a *limited* condensation of the diploë, but in such cases the adjacent bone-tissue shows evidence of inflammation, and it is hardly possible to conceive a cranitis that would evenly and precisely involve every part of the vault, and yet cause no symptoms, and be associated with no changes on the surface of either of the skull-plates.

3. The term *osteo-porosis* has been applied to the condition found in certain large, thick skulls with obliterated sutures, the bones of which on section appear uniform, and finely porous, and, to use a comparison of Sir James Paget's, very like white brick. The general shape of the skull is, as a rule, not altered, but the thickness of the component bones may be extreme, and represent four or five times the normal width on section. In the Musée Dupuytren is a skull, for example, four centimetres in thickness. Both the surfaces of the bones are generally smooth, but the vascular channels on the inner table are greatly increased in depth. The change is, more or less, entirely limited to the vault, although, in some cases, the base may be implicated. This condition of skull, known by some as diffuse excentric hyperostosis, is the outcome of several different diseases, among which may be placed, with some certainty, (1) osteitis deformans; (2) osteomalacia; and (3) a peculiar form of rickets (?), occurring in animals.

¹ See cases in Med.-Chir. Trans., vol. xix. p. 367. 1833; also in article "Cerveau," by M. Potain, Dict. Encyclop., p. 294. Paris, 1873. In November, 1881, Mr. Pearce Gould exhibited at the Path. Soc. of London, the occipital bone from a patient with congenital absence of one lobe of the cerebellum. The bone showed a true hypertrophy at the part corresponding to the absent lobe.

(1) One of the most conspicuous features in osteitis deformans is this change in the skull, and there is no doubt that several specimens in museums ascribed to syphilis, to the effects of blows, and to compensatory hypertrophy after wasting of the brain, are examples really of this remarkable disease.¹

(2) In cases of cranio-malacia the skull-bones become greatly and evenly thickened, the sutures are obliterated, and the texture of the bone is light, spongy, and very brittle.²

(3) In the museum of the Royal College of Surgeons are several skulls of young lions and monkeys, that have died in confinement of a disease resembling rickets in man, and that without doubt depended upon improper diet. In these skulls, the entire vault is evenly and greatly thickened, the sutures are obliterated, and the base is not involved. The bone is very uniform on section, and is very finely porous. What is the exact nature of the affection it is impossible to say; and, indeed, the whole pathology of so-called osteoporosis of the skull is in a condition of extreme obscurity.

4. In the condition known as *limited eccentric hyperostosis*, the skull is thickened and deformed by the growth of irregular bossy masses of rough and porous bone. These masses appear to be deposited upon the outer, or sometimes upon the inner, table of the skull, but an examination of the bone in section shows that its whole structure is involved in the disease. The disease spreads; the bones of the face and lower jaw are involved. The malar bones are especially apt to be affected, and may be converted into bossy masses as large as oranges. As regards the skull, the frontal and parietal bones are those most severely involved, while the occipital bone is, as a rule, but slightly affected, and may remain absolutely exempt from the disease. The deformity produced by the disease is extreme and horrible; the cavities of the skull, nose, orbit, and mouth are encroached upon. The cranial foramina are narrowed, and may even become closed. Paralysis of the nerves at the base of the skull is therefore not uncommon, and the patient usually dies, simply worn out by the effects of the disease. The morbid change is usually very symmetrical. The bone is very vascular, and is rendered porous by the entrance of many bloodvessels. Virchow considered this disease to be akin to elephantiasis of the soft parts, and gave to it the name of *leontiasis ossium*. It occurs most usually in the young, appearing at or before puberty, and lasts for years. In a very fully reported case, recorded by Dr. Murchison, the disease had existed for twenty years.³ It is commonly attended by more or less continuous headache, by neuralgia, spasms, or limited palsies. Like the other forms of skull hypertrophy, it is unaffected by any treatment.

ATROPHY OF THE SKULL.—Atrophy of the skull, or *anomalosis cranii*, appears under various forms. Considered generally, it is an affection of old age, being quite rare before the age of 50. It would appear to be most common in the female sex, for out of 28 cases mentioned by M. Gayraud,⁴ the patients in 22 instances were women.

This subject has been very fully investigated by M. Sauvage,⁵ who asserts that he met with twenty-eight cases of atrophy in examining two thousand adult skulls. This proportion, however, is probably too high.

The condition and extent of the atrophied parts vary considerably. In

¹ See Sir James Paget's paper, *Med.-Chir. Trans.*, vol. xlii. p. 37. 1877; also case reported by author in *Trans. Path. Soc.*, 1881.

² A good specimen will be found in the Museum of the Royal College of Surgeons (Mr. Solly's case).

³ *Trans. Path. Soc.*, vol. xvii. p. 243. 1866.

⁴ *Dict. Encyclop. des Sciences Méd.*, Art. Crâne. Paris, 1879.

⁵ *Recherches sur l'État sénile du Crâne*. Paris, 1869.

some cases, the bone loses its volume by progressive wasting of the diploë and approximation of the two cranial tables. These tables at last meet in one compact layer, and, by becoming themselves still further thinned, may, in time, exhibit actual perforations in parts. This condition may be general, or it may involve parts only. Parts of the skull, naturally thin, show this change most conspicuously, as for example, the lower part of the occiput, the squamous portion of the temporal bone, and the orbital roof. In other cases the absorption appears rather to take place centrifugally from one or more points, and may then commence in either of the two tables, or in the diploë. Most usually it commences in the outer plate. The entire skull may be thus involved, and a severe example of one phase of this condition is afforded in osteo-malacia.

One of the most peculiar forms of the present affection is a limited atrophy of a part of both parietal bones, whereby very distinctive depressions are produced on the outer aspects of the bones. These "parietal depressions" are met with in the skulls of the aged, and are symmetrical, although they are usually more marked on the right side. The depression is oval, is situate over the parietal eminence, and has its long axis placed obliquely, so that it is directed from the posterior and upper part of the bone, forwards, and a little outwards or downwards. The depression may occupy the greater part of the antero-posterior diameter of the bone. The depression is at the expense of the outer table and the diploë. The inner table will be found unaltered in position, and the cranial cavity, therefore, is no way encroached upon.¹ In some cases, however, the disease may go on to perforation.² The causes of this remarkable affection are unknown.³ There is on record a case of symmetrical atrophy of the frontal bone on either side of the middle line, and several cases of like atrophy of the occipital bone.

Atrophy of the skull is attended by no special *symptoms*, cannot be *diagnosed*, and, even if recognized during life, would probably be unaffected by any *treatment*.

CRANIOTABES AND THE CHANGES IN THE SKULL IN HEREDITARY SYPHILIS.—The term *craniotabes* is applied to two morbid conditions met with in the crania of young infants, that differ, however, only in degree. They are (1) a limited thinning of the skull bones, and (2) perforations in those bones due to extreme degrees of that thinness. Elsaesser,⁴ who first described the affection, considered it to be due to rickets, but at the present time, owing mainly to the researches of M. Parrot, Dr. Barlow, and Dr. Lees, the condition is considered to be a manifestation of hereditary syphilis. The conclusions of the two last-named observers upon this point are thus expressed: "We have found craniotabes (1) not common in pure rickets, (2) not at all special to rickets, (3) very common in congenital syphilis."⁵ The changes in the skull in syphilitic infants present themselves under three aspects: 1. Gelatiniform atrophy (Parrot⁶); 2. Craniotabes; 3. Osteophytic formations. These changes occur in varying degrees and at somewhat varying periods, and it is important also to observe that these changes do not occur in the crania of *all* syphilitic infants.

¹ An excellent description of these depressions is given by Professor Humphry. *Journ. Anat. and Phys.*, vol. vii. p. 136. 1874.

² Larrey, *Bull. de la Soc. de Chirurg.*, tome vii. p. 30. 1867.

³ The subject of causation is well discussed by M. Pozzi. *Dict. Encyc. des Sc. Méd.*, Art. Crâne (Développement), p. 497.

⁴ *Der weiche Hinterkopf. Ein Beitrag zur Physiol. und Pathol. der ersten Kindheit.* Stuttgart und Tübingen, 1843.

⁵ *Trans. Path. Soc. Lond.*, vol. xxx. p. 333. 1879.

⁶ *Ibid.*, p. 339.

1. *Gelatiniform atrophy* is very rare, and is met with only in very young infants, so that M. Parrot suggests that it may commence during intra-uterine life. The bones affected waste and assume a somewhat gelatinous aspect, being soft and watery; the surface of the affected portions looks eroded when the specimen is fresh. The change always commences at the surface, beneath the periosteum, and is very seldom of any depth, although M. Parrot mentions a case in which it produced perforation. It may be circumscribed or diffuse, and may involve any or all of the cranial bones.

2. *Craniotabes* appears mainly about the lambdoid suture, affecting the upper part of the occipital bone and the posterior border of the parietal bones. It consists of a great thinning of the bone, which thinning is mainly at the expense of the inner surface, so that when holes are formed, they cannot well be felt in the fresh specimen by passing the finger very lightly over the external surface of the bone. The thinned bone yields to the finger like parchment, and this parchment condition has been observed in the lower part of the occipital bone, and also in the squamous bone. The holes are generally small, about the size of a bean, and are filled in by a thin membrane. These changes occur mainly from the third to the sixth month, and occupy a period somewhat antecedent to that of the osteophytes.

3. The *osteophytic* formations consist of certain local thickenings of the skull. These appear as lens-shaped elevations on the exterior of the bone, and may increase considerably in size. Their most constant position is about the anterior fontanelle. Here bosses form on the four bones that form the fontanelle, and give rise to a remarkable elevation, traversed by depressions arranged in a crucial manner, and marking the situations of the coronal, sagittal, and interfrontal sutures at the point where these sutures meet. The anterior fontanelle, therefore, appears to be at the bottom of a hollow formed by the heaping up of the adjacent bones. Sometimes only two bosses exist instead of four. These changes appear first on the frontal bones, and then on the parietals; the occipital bone may also be affected, but not primarily. The elevations are composed of a very porous bone formation, and are of a red, violet, or maroon color; they involve the exterior of the skull only, the corresponding part of the inner table being unaltered. The thickening tends to extend from the fontanelle along the sutures first, and ultimately over the general surface of the bones. The centres of ossification are the points last attacked, so that the frontal and parietal eminences are very seldom the seat of these bone thickenings. By an extension of the enlargement, the whole skull may become much thickened, the sutures obliterated, and the development of the brain considerably hampered. These osteophytes appear to be formed from the deeper layer of the periosteum, and present the structure of very imperfect bone. Dr. Barlow considers them to be due to a hyperostosis depending upon altered nutrition, and not to be of the nature of periostitis. They appear in older children than those affected with atrophy, so that the two conditions never coexist. *Craniotabes* and *osteophytic* growth are, however, often met with on the same skull, but on quite opposite parts, the osteophytes being on that part of the skull which is most elevated in dorsal decubitus, the *craniotabes* on those parts which are the most dependent. It is usual, therefore, to ascribe the latter condition to pressure. Taken as a whole, all these changes appear early, certainly within the first two years of life, and usually well within the first year.

Diagnosis.—The condition of gelatiniform atrophy cannot be diagnosed during life. (Parrot.) *Craniotabes* is easily recognized by the parchment-like reaction of the bone under pressure, and by the presence of the holes. The latter are, however, much less easily recognized than is the former condition. The osteophytic condition can be recognized during life, if the enlargement

is in any way pronounced, and so peculiar often is the general outline of the deformity about the anterior fontanelle, that M. Parrot speaks of it as the "natiform" deformity. The general condition of the infants who are the subjects of these skull changes needs no mention in this place, nor does the *treatment* of the constitutional malady. The only local treatment to be advised is to keep the back of the head free from pressure, and this is easily effected by the use of a ring of cotton-wool, or some such simple contrivance.

TUMORS OF THE SKULL.

CYSTS OF THE SKULL.—Some few cases have been recorded of cysts developed within the substance of the cranial bones. It is probable that in every instance these were hydatid cysts. Four examples of cyst have been cited by Bruns; of these, three were located on the vault, and one on the base of the skull. One of the best recorded cases of this affection is that detailed by Robert Keate.¹ A female, aged 18, presented a large tumor on the frontal bone, that occupied nearly the whole of the left half of the bone, and extended some way across the right half. It had been growing slowly for six years. The patient complained of headache, vertigo, sickness, and noises in the ears. On attempting to remove the tumor, which was of bony hardness, it was found to be composed of a cyst in the substance of the bone, lined by a membrane. A clear fluid escaped from it. The cyst had evidently developed in the diploë and had separated the two tables, the inner plate being depressed towards the cranial cavity. The contents having been evacuated, the wound was allowed to heal. The cyst re-formed, and, on being re-opened, many small cysts were found embedded in the wall of the original cyst. Attempts were made to destroy the growth with caustics, and ultimately, after an application of the saw and much exfoliation of bone, the wound healed, and a complete cure resulted. No microscopic examination was made of the cyst-contents, but there can be little doubt that the growth was due to the hydatid parasite. In a case recorded by Holscher,² a hydatid cyst appears to have developed from the dura mater beneath the parietal bone, and to have perforated that bone and so formed an external tumor. This tumor was soft and fluctuating, with a distinct rim of bone at its base. It suppurred, and on incision a number of hydatids were evacuated. The patient, a lad aged 14, did remarkably well. Clémenceau gives a case of spontaneous cure of a hydatid cyst of the brain, brought about by its opening externally.

SARCOMA OF THE SKULL.—Sarcomatous growths from the cranial bones are not very uncommon, and probably most of the cases of cancer of the skull, described by older authors, were of this nature.

The tumors may grow either from the surface of the skull (pericranial sarcoma) or may commence in the diploë (diploic sarcoma).

In the *pericranial* form, a tumor rapidly develops beneath the pericranium, and separates it more or less extensively from the subjacent bone. The sarcomatous growth soon penetrates into the osseous tissue at its base, diving in at many points so that the bone becomes riddled with the new material. Fine bony trabeculae form early on the substance of these tumors. The trabeculae radiate from the base of the growth, and serve to support the softer parts. The amount and density of this trabecular tissue vary greatly. As the mass extends externally, it forms a large, rounded, or lobulated mass, very distinctly outlined. The growth at the same time spreads more deeply into

¹ Med.-Chir. Trans., vol. x. p. 279. 1819.

² Heineke, loc. cit., p. 78.

the substance of the bone; ultimately, perhaps, penetrates the inner cranial plate; and extends then between the bone and the dura mater. The sarcoma generally spreads evenly over the dura mater, forming a flattened rather than a rounded elevation of that membrane towards the cranial cavity. In time, also, the dura mater itself may become invaded by the growth.

In the *diploic* form, a very similar course is observed. The mass commences in the diploë, and slowly separates and expands the cranial plates. The growth naturally tends towards the external surface as the direction of least resistance. The outer table becomes expanded and thinned, until it forms a mere cap of bone over the now fair-sized swelling. In time this bony cap gives way, and the growth appears immediately beneath the soft tissues of the pericranium and scalp. Some displacement and expansion of the inner skull-plate may be observed, but it is not common in any but a trifling degree.

Sarcomata of the cranium may be primary or secondary. Most often they are secondary to like tumors elsewhere. They are usually multiple, seldom affect the corresponding glands, and, when primary, are very apt to lead to metastases in various parts. They are most common in youth and middle life. Some few cases are recorded in quite young children,¹ and Mr. Birkett² has described a case of myeloid sarcoma of the frontal bone in an infant aged two months. The patient lived nine months after the appearance of the growth. Mr. Butlin³ observes that these sarcomata in young children are usually of the round-celled variety, that they are nearly always multiple, and that they kill by metastatic formations.

Microscopically, these tumors are usually of the spindle-celled variety, especially such as grow beneath the pericranium. The more rapidly growing tumors are, as a rule, examples of round-celled sarcoma, and in any variety a certain proportion of myeloid cells is usually to be found.

Symptoms, &c.—These growths first appear as small, flat, rounded masses, which are deeply placed and very fixed. Their appearance may be preceded by headache and local pain, and these symptoms are more apt to occur in connection with tumors growing from the diploë. These growths are at first of bony hardness, and may well be mistaken for exostoses. In the case of the diploic tumor, the covering of the growth is actually of bone; in the case of the more superficial growths, there is a covering of tense pericranium. The mass enlarges rapidly, and becomes softer; if it has expanded the bone, egg-shell crackling will be detected at some period. At last, a roundish, tuberous tumor is developed, that feels soft, and perhaps in places almost fluctuating. The skin becomes gradually thinned over the mass, the hair falls off, and in time the sarcomatous material protrudes through the integuments. Often around the edge of the tumor, at its base, a raised rim of bone can be detected, and perhaps portions of the long trabeculae may be felt in the substance of the mass. The growths, as already observed, are apt to be multiple, and to be associated with metastatic deposits. They may attain great size, especially if they occur in parts where facilities are offered for extension. Mr. Toynbee⁴ records the case of a female, aged nineteen, from whose occipital bone grew a mass that in three years' time occupied the greater part of the neck on one side. It would appear from the accounts given to have been a spindle-celled sarcoma. Mr. Stanley⁵ also records a case in which an enormous tumor developed from the vertex in a lad, aged fifteen. It looked like "an additional cranium growing from the vault of the skull." The patient died with brain symptoms three years from the first appearance of the disease. At the autopsy,

¹ See case occurring in a child aged four. Path. Soc. Trans. 1879.

² Path. Soc. Trans., vol. ii. p. 232. 1859.

³ Report of Proceedings of Path. Soc., Lancet, Nov. 1879.

⁴ Path. Soc. Trans., vol. ii. p. 243.

⁵ Ibid., vol. iii. p. 415.

the mass was found to have penetrated the bone, and to have spread out over the inner surface of the skull. There is little doubt, from the account given of the microscopic appearances, that this was also a spindle-celled sarcoma. In cases where the growth has invaded the interior of the cranium, various brain symptoms may be produced, such as vertigo, vomiting, severe headache, convulsions, paralysis, etc.

The *prognosis* is bad in all cases. Death may occur from exhaustion, or may be consequent upon the suppuration and breaking down of the growth; or from this condition pyemia may ensue, associated probably with thrombosis of the sinuses. In most cases, however, death is due either to brain complications or to the development of metastatic masses in distant parts. The patient may survive for many years. Dr. Ogle¹ records a case of what was no doubt sarcoma of the skull that had perforated both tables, where the patient lived for sixteen years after the first appearance of the tumor. He died of gangrene of the lung, but during a greater part of the sixteen years had been troubled with epileptic attacks and other evidences of brain disturbance.

In the matter of *treatment*, little or nothing can be done. It is needless to observe that the practice adopted some years ago of recklessly trephining out portions of the morbid tissue, is worse than useless. Heineke² advises that in quite recent cases, when the tumor is small, and especially when it is of periosteal origin, an attempt should be made to remove the mass by cutting away successive portions of the skull with a chisel. In this way he suggests that the morbid tissue may be quite removed, together with some of the adjacent healthy bone. But, in actual fact, the nature of these tumors is seldom recognized until they have reached a fair size, and have involved an extent of the skullcap not anticipated by Heineke's operation. Moreover, they are very often multiple. It thus happens that in the majority of cases no operation is to be advised.

CARCINOMA OF THE SKULL.—Carcinoma of the cranial bones is always secondary. (Heineke.) It is very certain that the majority of the cases of skull cancer recorded by the older authors, were cases of rapidly growing sarcomata. The form of carcinoma that would involve these bones is the encephaloid, and it would appear that the growth seldom attains such dimensions as to form a manifest tumor. Should it form a distinct tumor, the course and symptoms would resemble those already detailed as pertaining to the sarcomata. The progress of the disease, however, would be more rapid, and it would prove fatal at an earlier period.

ANGEIOMA OF THE SKULL.—Angeliomata of the scalp may, by a process of extension, involve the subjacent cranial bones. Apart from this mode of origin, however, angioma of the skull may arise independently from these bones, and constitute distinct affections. They may have their origin from the surface of the bone, but more often would appear to be developed in the substance of the diploë. The affected bone becomes invaded with the vascular growth, and when that growth has origin in the diploë, the cranial plates may become more or less expanded, and replaced by the morbid tissue. The bones most often affected are the frontal and parietal. At the seat of disease, the osseous tissue is seen to be occupied by irregular, cavernous spaces, supplied by a vast number of dilated vessels.³ The *mischief* is seldom of great extent, although Virchow records the case of an old woman, one of whose parietal bones was almost entirely transformed into a cavernous erectile tumor. If the mass is

¹ British and Foreign Med.-Chir. Rev., vol. xxxv. p. 498. 1865.

² Loc. cit., S. 83.

³ See Fig. 535, Vol. II., page 819, taken from Erichsen, to show an aneurism by anastomosis of one of the parietal bones.

very large, pulsation of a feeble character may be evident. It would appear that these angeiomata, as a rule, cause no trouble, and therefore require no active treatment. It will be obvious that any operative procedures directed against a vascular growth, large enough to cause trouble, would be associated with insurmountable difficulties and dangers if directed against the part itself. On the other hand, it is doubtful if carotid ligature would affect the progress of the growth with any great certainty.

EXOSTOSES.—Bony tumors of the skull may be divided into three classes, according to their situation or point of origin. Those that grow from the outer table are termed *exostoses*, those from the inner *enostoses*, and those that spring from the diploë of the bone receive the name of *parenchymatous exostoses*. Considered with reference to their structure, these growths may again be divided into *ivory* tumors, *compact* tumors, and *cancellous* or *spongy* tumors. The ivory tumor is by far the most common of these, being, indeed, almost limited to the bones of the head and face; and, on the other hand, if one regards the situation of the mass, the most common growth will be that classed with the exostoses.

The *causes* of these tumors are but little known; some appear to be real new growths, others to be but partial hypertrophies of existing bone-tissue, and very many to be of inflammatory origin. Often, therefore, no cause can be ascribed to explain the production of these tumors. The symmetry which they at times exhibit, and the great number of growths that one skull may present, would suggest some very general cause in some instances. Follin and Duplay¹ quote from Hauff, the case of a woman in whom each succeeding pregnancy increased the size of a bony growth; and the same authors also mention prolonged exanthems of the scalp as a cause of at least one form of this malady. The osteomata of inflammatory origin are, however, easily explained. The great bulk of them are due to tertiary syphilis—to an osteo-periostitis occurring in that affection—while others can be traced to an injury, a blow or a fracture, followed by some inflammatory change in the part.

The *structure* of these masses is simple. The *ivory* osteoma is, as a rule, made up of concentric bone lamellæ arranged parallel to the surface of the tumor, while among the lamellæ bone-corpuscles are found, whose canaliculi radiate towards the periphery, as they do in tooth cement. The growth is non-vascular. It has to the naked eye the appearance of ivory, and its white or yellowish-white color readily distinguishes it from the adjacent bone, so that, by these means, an ivory exostosis the size of a pin's head can be easily detected.² The *spongy* tumors have a structure like that of the cancellous tissue or medulla of bone, and are provided with a thin covering of compact tissue. The *compact* osteoma is intermediate between these two varieties. Its tissue is like that of the compact tissue of long bones. On section it appears porous, and its lamellæ are, as a rule, concentrically arranged around vascular canals. Its color is so like that of the adjacent bone, that it forms tumors much less conspicuous to the eye, when small, than are the ivory osteomata.

On microscopic section, these bone tumors are readily distinguished from the ancient bone, owing to the fact that the Haversian canals in the growths are nearly always arranged perpendicularly or obliquely to those of the original tissue.³ In every instance, the adjacent pericranium is continued over the surface of the exostosis.

¹ Traité de Path. Ext., tome iii. p. 577.

² Hewett, Exostoses of Skull. St. George's Hosp. Reports, vol. iv. p. 3. 1869.

³ Cornil et Ranvier, Man. d'Histologie Path., tome i. p. 267. 1881.

Connection.—The parenchymatous growth may assume the form of a distinct or an ill-defined conversion of the diploë into a compact or ivory mass. Usually, however, a tumor is formed which may project externally, internally, or in both directions. Sometimes the connections of exostoses, especially of the larger masses, to the skull, appear to be very slender, a slight degree of force separating the tumor, and separation, indeed, in rare instances, occurring spontaneously.¹ As a rule, the inner or outer table, as the case may be, of the affected spot, is lost in the tumor, but in the Musée Dupuytren is a skull with a cancellous enostosis, beneath which the inner table is to be traced, distinct and unaltered, between the tumor and the rest of the skull. Sir Prescott Hewett states that he has seen similar cases.² Some cranial osteomata may grow from the sinuses of the skull, mostly from those in the frontal bone, but also from the ethmoidal and sphenoidal sinuses. Much has been written as to the origin of bony growths in these parts, but still nothing certain is known as to their anatomical parentage. Certain it is that they form some of the very densest, largest, and most irregular exostoses of the skull; that they may cause terrible deformity; and that, at the same time, they often possess a singularly frail connection with the main bone. The bone in the vicinity of cranial osteomata may be normal, but it is often unduly porous, and is sometimes thickened. If an exostosis involves a suture, it usually solders the two connected bones together at the spot affected; but Hewett³ records a case in which a suture was continuous through the middle of an ivory exostosis, so that when the skull was disarticulated the mass appeared in halves.

Seat.—Most exostoses grow from the vault, and most commonly from the frontal bone; next in frequency must be mentioned the mastoid process, and lastly, the occipital bone. As before observed, the tumors are often symmetrical. A few osteomata have been met with on the base of the skull, and allusion has already been made to those which spring from the sinuses.

Number, Shape, and Size.—The number of growths in any given case varies. If very large, the mass is usually single, and this remark especially applies to those tumors which grow from the sinuses. They are very often multiple and irregularly distributed. A skull in St. George's Hospital Museum shows no less than nineteen exostoses. The shape of these tumors varies greatly. Some are rounded elevations, others assume a conical shape, others are pointed and spine-like, and others most irregular and bossy. Occasionally they have a pedicle, and this may give them a very peculiar outline on section.⁴ The majority, however, possess a broad base. Their size is equally variable. Some ivory exostoses may be met with as small as little peas; and they commonly do not exceed the size of a hazel-nut. The cancellous tumors are often larger, and may indeed attain a considerable size. The largest bone masses, however, belong to those tumors that spring from the sinuses.

Symptoms.—As a rule, these growths, when external, cause absolutely no symptoms, although those of inflammatory origin may be at first associated with vague pains, worse at night and increased by pressure. Their rate of growth is slow, and is measured by years, and they may at any time become stationary. The enostoses may also cause no trouble, but in some cases they induce brain disturbances, shown by such symptoms as severe headache, convulsions, epilepsy, amaurosis, deafness, and partial paralysis. In one case at least (Lecat's) the patient died of compression, and M. Gayraud speaks of a patient dying with symptoms of meningitis.⁵ Those near the orbit may

¹ See instances quoted by Sir P. Hewett, loc. cit., p. 3.

² Loc. cit., p. 4.

³ Loc. cit., p. 6.

⁴ Quain, Trans. Path. Soc. Lond., vol. iii. p. 149.

⁵ Dict. Encycl. des Sc. Med., Art. Crâne, p. 528. 1879.

grow into that cavity, and cause protrusion or destruction of the globe; or in like manner they may invade, to some extent, the cavity of the nose or pharynx. The exostoses are readily recognized by their bony hardness, harmless character, extremely slow growth, and absolute fixity. The existence of enostoses can merely be suspected, and then only in cases where brain symptoms have been produced. In confirming such a suspicion, the points of most value would be a history of syphilis or of previous injury, the discovery of exostoses on the surface, and a knowledge of the doctrines of cerebral localization.

Treatment.—As exostoses are innocent, and seldom cause even mechanical inconvenience, they should be let alone. If any external tumor is large enough to cause mechanical trouble, it will also be too large to remove. If with an exostosis one has reason, from localized brain mischief, to suspect a corresponding enostosis, the part may be trephined if the mass be small; or, in any case—especially cases with a history of distinct previous injury—where the cerebral disturbance is thoroughly well localized, the skull may be trephined for suspected enostosis. Many external tumors, some of great size, have been removed from the skull in past times; but such operations must be regarded rather as relics of the barbarian age of surgery. The accounts of some of these proceedings with hammer, chisel, and saw, are fearful to read.¹ In all cases with a history of syphilis, appropriate treatment should be adopted.

FUNGUS OF THE DURA MATER.

This term is applied to certain tumors which, springing from the dura mater, in time perforate the skull and appear externally beneath the scalp.

Pathology.—Many tumors of various kinds may have their origin in the dura mater, but it is only a very small segment of them that ever make their way through the cranial bones. There are, for example, fibrous, fatty, and osseous tumors of the dura mater.² These never perforate the skull. On the other hand, growths arising from other parts within the cranial cavity, besides the dura mater, may under certain circumstances penetrate the bone and appear superficially. Thus, sarcomatous growths from the arachnoid may perforate the skull, and Lancereaux³ cites a case of “lipoma” of the pia mater, in which the intracranial tumor was continuous through a deficiency in the skull with a like tumor beneath the scalp. It is probable that this particular growth was congenital. Carcinoma of the brain also may project externally after having made a hole in the bones that cover it.⁴ The same may possibly be said of some sarcomata of the brain, and of malignant and sarcomatous growths from the pia mater. All these examples, however, of perforating tumor are extremely rare. It is indeed quite the exception for growths from the brain or softer meninges to penetrate the bone, and thus it happens that in nearly all instances of such perforation the tumor has its origin from the dura mater.

Fungus of the dura mater may occur either as a *primary*, or as a *secondary* tumor. In the latter instance it is due to metastasis in connection with a like growth or growths elsewhere. In some few instances the growth may

¹ In some of these cases the dura mater was freely exposed; in other instances the surgeon hammered at the patient's skull for three or four hours at a sitting, and applied the trephine some six or eight times.

² See for examples, Path. Soc. Trans., vol. vii. p. 1; vol. viii. p. 13; vol. x. p. 10. Lancet, vol. i. 1872, p. 147; vol. ii. 1873, pp. 660, 837, etc.

³ Traité d'Anatomie Pathologique, tome ii. première partie, p. 448. Paris, 1879.

⁴ Ball et Krishaber, Dict. Encycl. des Sc. Méd., Art. Cerveau (Pathologie), p. 439. 1879; Malespine, Thèse de Paris, No. 14, 1846.

spread to the dura mater from neighboring parts, as for example, from the orbit.

The primary tumors are nearly always single, the secondary tumors are not infrequently multiple. Moreover, the growth of the secondary masses is usually more rapid than is that of the primary forms of the disease.

Structure.—As regards structure, these growths from the dura mater are *sarcomatous*. With reference to the primary tumors, I think that this statement may be accepted absolutely, but there is some slight and doubtful evidence in support of the assertion made by some that certain of the secondary forms of the malady may be *carcinomatous*. Less recent observers almost invariably speak of these tumors as cancerous, but there can be little doubt, from the descriptions which they give, that they dealt with sarcomatous new growths. These tumors indeed have in a marked degree the clinical and physical features that distinguish the sarcomata from the carcinomata. They are, as a rule, well encapsuled; they displace rather than invade the parts around (frequent reference is made to the ease with which they shell out on post-mortem examination); they usually attain a large size before they break down; their rate of growth is usually less rapid than that observed in most carcinomata; they seldom induce glandular enlargements; and, lastly, they are often attended by metastasis. All these features are appropriate to sarcoma and not to carcinoma. Lancereaux¹ and other observers assert that metastatic carcinoma never occurs in the dura mater, and in, I think, all of the more recent accounts given of the microscopic aspect of these fungous growths, it has been shown that they were sarcomatous. The following may be taken as examples of the cases that appear to support the view of the possibility of metastatic carcinoma of the dura mater. Dr. Williams² records the case of a female, aged fifty-six, who had presented a scirrhus of the breast for ten years. For five years she had had "cancer of the abdomen." Scirrhus tubercles afterwards appeared on the skin of the chest and abdomen. After certain head symptoms she died. The dura mater presented many round and firm nodules of "cancer." In this case the report is hardly full enough, and the long duration of the breast tumor is somewhat opposed to the diagnosis of scirrhus. Dr. Habershon³ reports the case of a female, aged twenty-nine, who had had a scirrhus of the breast that had recurred after removal. She developed fungus of the dura mater. At the autopsy, many nodules were found on the dura mater, and there was besides "cancer" of the clavicle, ribs, humerus, bronchial glands, liver, and pleura. A drawing is given of the microscopic structure of the fungus, showing irregular cells in alveoli. Here the age of the patient is strongly against the notion of scirrhus, and much in favor of the diagnosis of sarcoma of the breast. The extensive metastases also are extremely suggestive of sarcoma, and it is striking that there is no mention of any glandular implication in the axilla. Many cases,⁴ akin to these, have been put on record, and it must be confessed that they do not satisfactorily demonstrate the existence of metastatic carcinoma of the dura mater.

It would appear that in a majority of instances this sarcomatous fungus is of the spindle-celled variety. In several cases it has been a round-celled sarcoma (and these are probably the growths mistaken for soft carcinoma); in other examples it has been described as a myxo-sarcoma, a glio-sarcoma, etc.

It must not be supposed that even the majority of the sarcomata of the dura mater perforate the skull. The majority do not perforate, but rather

¹ Op. cit., tome ii. p. 393.

² Path. Soc. Trans., vol. ii. p. 163.

³ Path. Soc. Trans., vol. vi. p. 321.

⁴ For an account of many such cases, see an Article by Dr. J. W. Ogle, On Morbid Growths of Brain and Cord, etc., in British and Foreign Med.-Chir. Rev., vol. xxxv. p. 486 *et seq.* 1865.

grow towards the brain and spread out between the dura mater and the bone. Some may grow deeply into the brain. It is obvious, moreover, that such of these tumors as grow from the base of the skull cannot well perforate unless located in certain situations. The course of the perforating tumor is as follows: It commences as a small, round nodule on, as a rule, the outer surface of the dura mater. As it increases, the bone adjacent to it undergoes slow absorption, and in time a hole is made which allows the morbid growth to escape. The holes thus formed are generally roundish, they present sharp and irregular edges, and show usually a greater destruction of the inner than of the outer table. Many older writers speak, therefore, of the bone being carious. In all cases the bone appears to be absorbed, and not to be infiltrated and thereby destroyed by the morbid growth. The tumor itself is well encapsuled, and, as a rule, easily separated, not only from the adjacent parts, but also from the dura mater itself. When the growth has reached the surface, it spreads rapidly over the skull, stretches the scalp, and ultimately—if the patient survives—breaks through the skin as a necrosing, suppurating mass. As a rule, the sarcoma spreads at the same time some way between the dura mater and the bone, and it may in any instance grow extensively in the direction of the brain.

As regards *seat*, the true fungus is met with on the vault, and the bones most frequently involved are the parietal, then the frontal, then the occipital or temporal together, perhaps with the great wing of the sphenoid. It may project into the orbit, nose, or pharynx, or may escape through the pterygo-maxillary fossa.¹

No *cause* can in most instances be ascribed for these growths, although very often they have appeared to follow upon an injury.² In some cases the tumor would seem to have been congenital. Fungus of the dura mater is equally common in the two sexes, and the most frequent period of life for it is between twenty and forty. It has been met with in young children; Louis, for example, records a case in a child, aged two years.

Symptoms and Diagnosis.—In most cases no symptoms precede the appearance of the tumor, the external tumor itself being the first thing noticed. In other instances, certain cerebral symptoms are observed as preliminary to the appearance of the growth, and these symptoms may be somewhat severe. They take the form of severe headache, or of violent neuralgic pains about the skull, of nausea or vomiting, of vertigo, of some confusion of ideas. In the severer instances there may be convulsions, partial or complete loss of sight or hearing, and slight muscular paralysis. Before the fungus actually appears above the surface, a soft spot of thinned bone may perhaps be felt, that crackles on pressure. Louis³ records a case in which the discovery of the tumor was made by a barber while shaving the patient's head. He noticed a faint sensation like the crackling of parchment when his razor passed over a certain spot. In a few days a tumor appeared at that spot. The external growth is at first small, flat, and firm. It exhibits pulsations transmitted to it from the brain, and can usually be reduced on pressure. This reduction makes evident a sharp-edged aperture in the skull, and the act itself may cause sudden pain to the patient, and induce vertigo, stupor, or even complete insensibility. As the mass increases it becomes rounded or bossy, and presents a distinctly constricted base. It becomes also softer and more elastic, and may appear to fluctuate at places. It is no longer reducible, and exhibits no pulsation, although in some instances it may present a feeble pulse due to

¹ Sir Wm. Lawrence, *Lancet*, August, 1853.

² For instances, see Louis's well-known monograph on "Fungous Tumors of the Dura Mater." *Memoirs of the Academy of Surgery*. Sydenham Society's Translation, p. 83. 1848.

³ *Loc. cit.*, p. 85

its contained bloodvessels, and not to impulses transmitted from the brain. The scalp becomes stretched over the prominent, growing mass; becomes hairless, thinned, and purplish; and in time perhaps gives way over a soft, fluctuating spot. So extensively may the tumor break down, that the finger introduced through the gap in the scalp, may feel the aperture in the skull. From this giving way of the scalp, severe hemorrhage may ensue. The tumor may attain a large size before the skin yields. Louis¹ records a case in which the growth was thirteen inches in circumference and seven inches in height, and on removal weighed four pounds and six ounces. Tumors of almost equal size have been noted by others. Sometimes the growth is attended by much pain. Louis imagines this to be due to the pressure of the mass against the sharp edges of the hole in the bone, and cites a case in which the patient found relief from severe pain and grave brain symptoms by lying in the position that caused the tumor to be the least prominent.

During the progress of the case there may be cerebral symptoms—such as headache, impairment of sight and hearing, vertigo, stupor, spasms, etc.—but more commonly these symptoms are absent. Louis reports a case in which the tumor was twelve inches in circumference, but in which the patient presented no symptoms of this kind.

In the matter of *diagnosis*, the general features of the case will be such as usually point out a sarcomatous growth. As long as the tumor is small, is reducible, and presents pulsations, little difficulty can occur in the diagnosis. It may in this stage be mistaken for encephalocele, from which, however, it should be early distinguished by the fact that the hernial tumor is congenital, is restricted as to its site, is softer to the touch, and does not present the comparatively rapid and deliberate growth of the so-called fungus. Vascular growths from the dura mater are preceded by some injury or disease of the bone (Heineke), and present, in addition to a strong pulsation in all their parts, a distinct bruit. When the tumor has attained some size and become fixed, and has lost all pulsation, the diagnosis may be more difficult. It can, however, scarcely be confounded with any growth other than a sarcoma of the cranial bones, and the points of difference between these two forms of sarcoma are, I think, well marked. The sarcomata from the bone are harder than those from the dura mater, and are, indeed, often covered with a cap of bone; they show less constriction at their base, and present in that situation very commonly a distinct osseous rim; moreover, they present in their interior bony trabeculae that can be detected with a fine needle. An incision made, as Heineke suggests, at the base of the fungus, would show that the edge of the bony gap had no connection with the substance of the growth, as it has in the case of sarcoma arising from the cranium. When the fungus appears in unwonted situations, errors in diagnosis are very prone to occur; and as an example of such I may cite a case reported by Dr. McKenzie,² of Glasgow, in which the fungus pierced the great wing of the sphenoid bone, and, appearing externally, was mistaken for an enlarged gland.

The *prognosis* in these cases is bad, the malady, left to itself, being invariably fatal. Death is due usually to increasing exhaustion and marasmus, or to implication of the softer meninges and brain. The duration of the disease is very variable; it may last for years,³ and on the whole does certainly exhibit a less rapid growth than do the majority of sarcomata. Some cases are, however, recorded, in which there has been a very rapidly fatal termination.

As regards *treatment* little is to be said. The external tumor should be

¹ Loc. cit., p. 112.

² London Medical Gazette. 1838.

³ Louis gives a case that existed for seven years, and another in which the tumor remained quiescent for twelve years, and then took on rapid growth. (Loc. cit., p. 112.)

protected from pressure and injury, and such general and local symptoms as arise should be met by the usual modes of treatment. If the mass ulcerate, it may be well to destroy the more prominent parts with the actual cautery. This procedure would greatly lessen for a while the suppurative action, and would add to the comfort of the patient. Operations for the entire removal of the mass are not to be advised, for such operations would fall short of their purpose, unless with the tumor was excised a considerable portion of the dura mater. Whether antiseptic surgery can render such procedures less fatal than they are at present, remains to be seen. These tumors have been subjected to a vast number of operations of various kinds at the hands of one surgeon and another, and certain of these so-called "modes of treatment" have been of the most horrible and reckless character. Many times have these sarcomata been incised, with in some instances a fatal hemorrhage; many times have they been ligatured, and in a still greater number of cases subjected to the action of some caustic. Of more elaborate operations, the performance of Berard¹ may well be taken as a conspicuous example. This surgeon, in an attempt to excise a fungus of the dura mater, made no less than sixteen trephine holes in a patient's skull. The unfortunate individual lived twenty-four hours. In only three instances have operations for the removal of tumors from the dura mater proved other than rapidly fatal. The patients in these instances were operated upon respectively by Grossmann,² Pecchioli,³ and Orioli;⁴ and in each case a cure of the disease is said to have resulted.

INTRACRANIAL ANEURISM.

Intraeranian aneurisms are not uncommon. They are mostly situated at the base of the skull, about the circle of Willis, and more often affect the carotid than the vertebral segment of that anastomosis. According to Quinke,⁵ the artery of the fossa Sylvii is the one most frequently affected, being involved in forty per cent. of all cases. The aneurism is apt to be found at the bifurcation of any given vessel. In size these tumors are as a rule small—some are very small; the average dimensions would be from those of a pea to those of a hazel-nut. Tumors of large size, however, have been met with; thus a case of multiloecular aneurism of the left posterior cerebral artery, the size of a small apple, has been reported by R. W. Smith.⁶ Aneurisms in this situation differ from aneurisms elsewhere in certain respects. In the first place, they do not observe the same restrictions with regard to age, but occur in the young with almost as much frequency as in those more advanced in life. Then again aneurisms elsewhere are—taken as a whole—of much more common occurrence in men than in women, whereas in these intracranial aneurisms, that disproportion is very much less marked. Lastly, intraeranian aneurisms appear to be often independent of preceding local changes in the vessels, and are probably due in a majority of cases to embolism. They are indeed often found associated with endocarditis and embolic lesions of various parts, especially in the young. In anatomical structure, moreover, they present certain peculiarities, which it is not necessary to discuss in this place. In growing they are apt to press rather upon the brain than upon the unyielding bone, although cases are recorded of absorptive destruction of some of the bony parts of the base of the skull. Their progress is most uncertain, and as a rule very slow. In three-fourths of all cases, a

¹ Gazette Médicale, tome i. p. 735. 1833.

² Stolz, Thèses de Haller, tome i. p. 169.

³ Gaz. Méd. 1838.

⁴ Bull. delle Scienze Mediche, Maggio, 1834.

⁵ Ziemssen's Cyclopaedia of the Practice of Medicine, vol. vi. page 440. 1876.

⁶ Dublin Journal of Medical Science, vol. xxv.

rupture of the aneurism is the mode of termination.¹ Several cases of spontaneous cure are recorded. Such are some of the chief facts in connection with intracranial aneurism.

It must be owned, however, that (in the present state of our knowledge, at least) these tumors have little concern with practical surgery. This concession must be made with some reservation, and must not include at least two intracranial aneurisms, viz., aneurism of the internal carotid artery, and aneurism of the middle meningeal. These aneurisms will receive separate consideration presently. With regard to the rest—the bulk of intracranial aneurisms—it may be said that they are at present excluded from the province of practical surgery for a twofold reason. The first of these deals with diagnosis. The majority of these aneurisms have not been recognized until the patient has reached the post-mortem room. In very many cases the tumor has produced absolutely no symptoms, and it has been only when death has occurred from other causes that the unsuspected aneurism has been discovered. In other cases, the only symptoms have been those that have immediately preceded death, and that have been due to the rupture of an aneurism of whose previous existence no evidence had been given.

In the most favorable cases, the diagnosis can be little more than conjectural, and would certainly not be clear enough to justify an operation, even presuming any operation to be proposed. The existence of a cerebral tumor may be recognized, but when the nature of the tumor is discussed, and the direct question asked—Is it aneurismal?—a chaotic district in medical knowledge is exposed, and a positive answer is seldom to be obtained. Immense progress has of late been made in this department of medicine, and no doubt in time this void will be filled up, but at present no basis is afforded for active surgical practice.

In the second place, supposing the diagnosis to have been made, can surgery do anything to cure or relieve the patient? At present the answer must certainly be in the negative—bearing in mind that we are quite excluding from these remarks the two special aneurisms already alluded to. Four large vessels enter into the circle of Willis; and so large are their contributions, and so free their anastomoses, that ligature of one, or even of two of the supplying trunks, would have but very doubtful prospects of success. Presuming that both carotids were tied, the circulation through the vertebrals would still be too vigorous to allow of much hope of good result. Indeed, I think it may safely be said that these particular intracranial aneurisms are at present beyond the reach of any surgical treatment. It would be foreign to the purpose of this work to discuss the symptoms that might be associated with these aneurisms; such an inquiry would open up a subject of immense interest and great complexity—the diagnosis and localization of cerebral tumors—a subject that is however at present more the concern of the physician than of the surgeon.

ANEURISM OF THE INTERNAL CAROTID ARTERY AT THE CAVERNOUS SINUS.—The symptoms of this aneurism vary somewhat, but, taken as a whole, are fairly characteristic. The symptoms often appear suddenly after an injury of some kind, or, on the other hand, may develop spontaneously, and assume a very leisurely and chronic course. There is usually frontal headache, that is often severe and associated with exacerbations, and that is sometimes located by the patient at the back part of one orbit. In addition, a rasping or sawing noise in the ears—or more particularly in the ear of the affected side—is complained of. With this there is not unfrequently vertigo, and an

¹ Ball et Krishaber, *Dict. Encyclop. des Sciences Méd.*, Art. Cerveau, p. 448. 1879.

inability to stoop, or to hang down the head. If the patient sleep with the head low, he is apt to be troubled with fearful dreams, and to wake up terrified.

On the whole, however, symptoms due to brain pressure are not observed with this aneurism, or only to some slight degree—the growth of the tumor, and its injurious contact with the brain, being opposed by the dura mater. Vomiting may occur, but is much less common than it is in other cerebral aneurisms, and epileptic attacks, muscular spasms, gross palsies, and intellectual troubles, are all either entirely absent or at least quite exceptional. The special symptoms depend upon lesion of the nerves in the cavernous sinus, the nerves most usually affected being the third and fifth, and then the fourth or sixth. The optic nerve appears to be seldom pressed upon. The special symptoms, therefore, will probably commence with ptosis, dilated pupil, and external strabismus, or with severe neuralgia of the first division of the fifth nerve, associated with photophobia, and sometimes with temporary congestion of the conjunctiva.¹ In time, paralysis of the fourth and sixth nerves usually follows, and the eye becomes motionless, but the loss of function in either of these nerves may not occur for a considerable time, as, for example, in Mr. Hutchinson's case, where the paralysis of the superior oblique muscle did not appear until ten years after the commencement of the symptoms.² As a rule, the neuralgia gives way to numbness of the forehead and some part of the face. The troubles of vision consist usually of loss of accommodation and diplopia. But there may be optic neuritis, and absolute blindness in the eye of the affected side.³ It is unnecessary perhaps to observe that all these pressure symptoms are strictly limited to one side. In addition to these evidences, a very distinct blowing bruit can be heard on auscultation over the affected side of the head, more especially about the anterior temporal region; and in those cases in which the cavernous sinus is much compressed, there may be vascular engorgement of the globe with undue prominence of the eyeball. This aneurism may undergo spontaneous cure, as occurred in the celebrated case reported by Mr. Hutchinson, and just referred to.

With regard to *treatment*, the only operative measure to be advised is ligation of the common carotid artery. This operation should not be performed until the diagnosis has been clearly established, and other means have failed to effect improvement. One must also assume that no obstacle to the operation is offered either by the patient's general health, or by the condition of the main artery in the neck. One such operation has been recorded. It occurred in the practice of Mr. Coe, of Bristol.⁴ The patient was a woman aged fifty-five, and the operation resulted in a complete cure.

ANEURISM OF THE MIDDLE MENINGEAL ARTERY.—Aneurisms of this vessel are extremely uncommon, and are usually, if not always, due to injury of some kind. They have a tendency to perforate the skull, and to appear externally beneath the scalp. Before such perforation occurs, the nature of the tumor may be a matter of much uncertainty. The symptoms before perforation are those due to pressure upon the brain. The patient complains of severe and often well-localized headache, of vertigo, of a constant buzzing in the ears, and of a tendency to faintness, and perhaps to vomiting. There may be moreover spasms in some particular set of muscles on the opposite side, or paralysis of those muscles, or even hemiplegia of the opposite side.⁵ In

¹ See a case recorded by Dr. Humble. *Lancet*, vol. ii. page 489. 1875.

² *Trans. Clinical Soc. Lond.* 1875.

³ J. W. Ogle, *Brit. and For. Med.-Chir. Review*, vol xxxvi. page 493. 1865.

⁴ *Association Journal*, page 1067. 1855.

⁵ *Follin et Duplay, Traité de Path. Ext.*, tome iii. p. 584. 1869.

addition, the patient will probably complain of a pulsation in the affected district, and on auscultation the aneurismal bruit may be heard. When the tumor perforates the skull, the diagnosis becomes much more evident. A tumor appears over the site of some main division of the middle meningeal artery, it pulsates distinctly, and, if large enough, may give to the fingers a sense of lateral expansion. It feels soft and fluctuating, and has possibly a slight thrill noticeable to the touch. On pressure being applied, the tumor will be found to be reducible, and, after such reduction, the hole in the bone may possibly be detected. This reduction moreover is not apt to be associated with cerebral symptoms. Pressure on the common carotid of the affected side causes diminution, or temporary disappearance, of the tumor, whereas pressure upon the opposite carotid increases the size of the mass. On auscultation, a distinct aneurismal bruit is to be heard over and around the site of the tumor. The diagnosis would also be aided by the history of the case, and by a knowledge of the symptoms experienced by the patient. In one case,¹ where a tumor had formed from perforation of the skull, the mass was mistaken for a cyst, and an operation was performed for its removal. Severe hemorrhage occurred from the incision. It could not be checked, and soon led to a fatal result. The only operative *treatment* applicable to these aneurisms is ligature of the common carotid of the affected side. Kremnitz² records a case in which this operation was performed for a meningeal aneurism that had perforated the skull, and had formed a large external tumor. It resulted in a complete cure, the hole in the skull being protected by the application of a silver plate.

CHRONIC HYDROCEPHALUS.

This term is applied to a disease characterized by certain accumulations of fluid within the cranial cavity. This fluid may be within the ventricles (internal hydrocephalus), or in the arachnoid sac (external hydrocephalus).

Internal hydrocephalus is the usual form of the disease. The accumulation of fluid in the arachnoid sac is rare, and, according to some authorities, is merely an accidental complication of the commoner form. Others maintain the independent existence of external hydrocephalus. The disease (considered generally) is as a rule congenital, or appears within the first six months after birth. It may however occur at any time before the sutures unite, or even after that event.

INTERNAL HYDROCEPHALUS.—The fluid, as just observed, usually occupies the ventricular cavities, and as a rule all those cavities (*viz.*, the lateral, the third, and the fourth ventricles). The dilatation is not always uniform, and not unfrequently involves one lateral ventricle or one part of such ventricle more considerably than the rest of the general cavity. The affected ventricles become immensely distended, and assume a rounded outline. The ganglia appear flattened out, and the various commissures stretched, or even removed. Owing to the ventricular enlargement, the convolutions of the brain become as it were unfolded, and more or less obliterated, and the cerebral mass between the ventricles and the surface becomes greatly thinned by the increasing distension. In certain severe cases, this brain matter may be reduced to a layer no thicker than one-half or one-quarter of an inch, and instances are recorded in which a mere film of brain tissue has in places bounded the mass

¹ Krimer, Journ. des Progrès des Sciences Méd., tome x. p. 237.

² Kremnitz, Deutsche Zeitschr. für Chirurgie, Bd. iv. S. 473. 1874.

of fluid in the ventricular cavities. It is possible for this thin layer to give way, and for the contained fluid to find its way into the arachnoid sac.¹ The quantity of dropsical fluid varies from a few ounces to quarts. In appearance it is clear, limpid, or slightly yellow, is of somewhat higher specific gravity than cerebro-spinal fluid, and contains but very little solid matter, in the form mainly of albumen and salts of sodium.

The *cause* usually ascribed for this disease is chronic inflammation of the lining membrane of the ventricles, while among less frequent causes are classed excess or deficiency of blood supply to the brain, with the various organic effects that follow such conditions, and certain malformations of the brain and its membranes.

Effects on the Skull.—The head enlarges mainly at the expense of its upper and lateral portions. The fontanelles become more open, and the sutures wider, while the bones of the vertex gradually recede from one another. The frontal bone is pressed forwards, the parietals backwards and outwards, and the occipital so much downwards that its vertical part may become almost horizontal. The enlargement is seldom quite symmetrical, and the head as a rule becomes conspicuously flattened at the top. The orbital plates of the frontal bone become depressed and oblique in direction, so that the orbits may be reduced to mere chinks. This change in the base of the skull is diagnostic of ventricular dropsy, as it never occurs in cases of external hydrocephalus. At the same time, it must be remembered that the orbital plate would not be affected in those rare cases in which ventricular dropsy had occurred after consolidation of the bones at the base of the skull.² At the sides of the cranium, the great wing of the sphenoid and the squamous bones are driven out, the temporal and zygomatic fossæ are filled up, and, if the deformity be severe, an appearance is given to the face as if the cheeks were greatly blown out. The scalp looks thin and tense, is covered with scanty hair, and presents on its surface many prominent veins. Fluctuation may generally be felt in the course of the open sutures, and these parts may sometimes be seen to sink and rise with respiration. With the greatly enlarged head the small and often emaciated face is in striking contrast. Owing to the frontal enlargement, the face has a somewhat triangular outline with the apex at the chin. If the orbital plate be much depressed the eyes are unduly prominent, and have an inclination downwards, so that often a good deal of the pupil may be concealed by the lower lid.

Symptoms.—Enlargement of the head is by no means of necessity the first symptom. Very often—especially in congenital cases—this enlargement is preceded by cerebral symptoms, such as convulsions, rolling of the eyes, squinting, paroxysms of screaming, restlessness, etc. The child wastes and becomes puny and ill-nourished. It cannot well support its head, and prefers to lie down rather than to sit. If it lives until it is old enough to walk, its gait is usually slow and cautious, like that of a decrepit old man; it is frequently idiotic, and is apt to be fretful and to exhibit paroxysms of passion. Children thus affected are liable to the brain disturbances already mentioned, and, in addition to these, may become the subjects of spasmodic croup, of muscular spasms in various parts of the body, and of muscular rigidity in one or more limbs.

Prognosis.—Death is the usual termination of these cases, and, unless it occurs at or soon after birth, commonly supervenes during the first or second years of life. The immediate cause of the fatal result may be exhaustion simply,

¹ Bright's Reports, vol. i. part i. page 433.

² Hewett, The Deviations of the Base of the Skull in Chronic Hydrocephalus; St. George's Hosp. Reports, vol. i. page 27. 1866.

or coma, or convulsions, or even acute cerebral mischief. Some children survive a few years, and some may even attain adult age, but such cases are very rare. In these instances the skull becomes in time solidified by the growth of new centres of ossification in the membranous parts, and by the increase also of the existing bones of the vault. The fluid ceases to increase, but it is doubtful if it is ever reabsorbed except under most unusual circumstances.

EXTERNAL HYDROCEPHALUS.—This condition is referred to three causes :¹ (1) to escape of fluid from ventricular dropsy ; (2) to congenital atrophy of the brain ; (3) to hemorrhage into the arachnoid sac. Apart from the absence of alteration in the base of the skull, it is doubtful if there are any absolute signs whereby an independent, external hydrocephalus may be diagnosed from the more common form of the disease. All the remarks, moreover, made upon this latter affection may be considered as also applicable to the form now under notice. Legendre² distinguishes the form due to hemorrhage by the facts that it is never congenital, that the head does not attain the size commonly seen in internal hydrocephalus, and that it is always preceded by convulsions, or other evidences of cerebral disturbance.

Treatment of Hydrocephalus.—With the general treatment of hydrocephalus the present article has no concern. The local treatment that has been proposed in certain cases consists (1) in the application of pressure, and (2) in paracentesis.

Pressure to the skull is maintained by means of strapping, or by an elastic bandage, the latter being the most suitable appliance. This treatment is applicable to nearly all those cases that are not absolutely hopeless, and that do not show evidence of a rapidly fatal termination. It can be regarded merely as a palliative measure, and may no doubt restrain the increase of the dropsy, at least for a while. The results of the treatment have been unsatisfactory, and for the most part negative. If it has done no good, it has at least done no harm, if exception be made of a few cases in which too vigorous pressure has induced symptoms of compression of the brain, and, in a case of Trousseau's, even death. The best mode of applying compression by means of plaster, is that advised by Trousseau, who gives the following directions. The plaster should be in strips one-third of an inch broad, and should be applied "1st, from each mastoid process to the outer part of the orbit of the opposite side ; 2d, from the hair at the back of the neck, along the longitudinal suture, to the root of the nose ; 3d, across the whole head, in such a manner that the different strips shall cross each other at the vertex ; 4th, a strip is cut long enough to go thrice around the head. Its first turn passes over the eyebrows, along the ears, and a little below the occipital protuberance, so that the ends of all the other strips shall project about one-quarter inch below the circular strip. These ends are next to be doubled up on the circular strip, and its remaining two turns are then to be passed over them just in the same direction as the first turn."³

Paracentesis.—Much difference of opinion exists as to the value of this operation for the relief of chronic hydrocephalus, and it must be confessed that the results of paracentesis have so far not been very satisfactory. West⁴ collected fifty-six cases in which tapping had been performed, and out of this number he considered that cure had followed in only four instances. It

¹ West, Diseases of Infancy and Childhood, 8th ed., page 130. 1874.

² Legendre, Recherches Anat. Path., p. 135. Quoted by West.

³ West, op. cit., page 133.

⁴ Medical Gazette, April, 1842.

must, in the first place, be allowed that the operation is not in itself dangerous, and that it is applied to a disease the prognosis of which is extremely grave. This point therefore can be urged in favor of the operation, that it is not likely to do much harm even if it effects little good. There is no doubt, however, that in many cases it has been followed by temporary relief, even if cure has not ultimately followed. The following appear to be the cases most suitable for paracentesis. As a general rule it may be practised in cases of great enlargement, with steady increase. In cases of external hydrocephalus, it is more likely to be followed by a good result than in cases of ventricular dropsy. It would be inapplicable to cases due to cerebral mal-development, and it is unfortunate that such cases cannot always be diagnosed, inasmuch as the functional disturbances that accompany the disease bear no constant relation to the amount of organic defect. Paracentesis is likely to fail in congenital cases, in cases associated with preceding acute cerebral disease, and in cases marked by extreme mal-nutrition. Indeed, in such instances, its employment is rather to be condemned. Malgaigne¹ advises the operation : 1st, in patients under four months old, in whom the disease appears stationary ; 2d, in children beyond that age, but who have not yet reached the period of complete cranial ossification, in whom the disease is increasing and threatening life.

The operation should be performed with a very fine trocar, which should be entered in the coronal suture, about one inch from the anterior fontanelle. The instrument should be thrust downwards, and a little backwards. Only a few ounces of fluid should be drawn off at a time, and the operation should be repeated at intervals of from a few days to a few weeks, according to the condition of the patient, and the rate at which the dropsy is increasing. Compression of the skull should be maintained, both during and after each operation. Dr. Thompson,² of Newcastle, reports a case in which two tappings ended in cure.

In some instances *iodine injections* have been associated with paracentesis, but so far with unsatisfactory results. Sir James Paget³ treated a case in this manner, throwing in about three ounces of a solution composed of ten grains of iodine and twenty grains of iodide of potassium to one ounce of water. The child died of convulsions three days after the second injection had been employed.

¹ Malgaigne, De la Ponction du Crâne dans l'Hydrocéphale chronique. Bull. de Thérap., tome xix. p. 226. 1840.

² Med.-Chir. Trans., vol. xlvii. page 289. 1864.

³ Medical Times and Gazette, vol. ii. page 613. 1860.

GENERAL SCHEME OF THE TUMORS OF THE VAULT OF THE SKULL.

ARRANGED FOR DIAGNOSTIC PURPOSES.

I.—TUMORS THAT COMMUNICATE WITH THE CRANIAL CAVITY.

[Common features: Reducibility. Pulsation. Increase on expiration. Hoie in bone often to be felt. May be cerebral disturbance on pressure or attempted reduction.]

A. CONGENITAL.

1. *Encephalocele*.
2. *Meningocele*.
3. *Hydrencephalocele*.
4. *External cephalhæmatoma*, communicating with an internal cephalhæmatoma through a perforation in the bone.

B. NOT CONGENITAL.

5. *Fungus of dura mater*.
6. *Aneurism of middle meningeal artery* that has perforated the bone.
7. *External venous tumor* communicating with the superior longitudinal sinus.
8. *External collection of pus* communicating with an internal collection through a perforation in the bone.

II.—TUMORS THAT DO NOT COMMUNICATE WITH THE CRANIAL CAVITY.

A. TUMORS THAT PULSATE.

1. *Aneurism*.
2. *Arterial erectile tumor*.
3. *Certain sarcomata of the cranial bones*.

B. GASEOUS TUMORS.

4. *Pneumatocele*, the only tumor tympanitic on percussion.

C. TUMORS WITH FLUID CONTENTS.

5. *Simple hæmatoma*, either (a) in substance of scalp; (b)*beneath aponeurosis; or (c) beneath pericranium; blood may be coagulated.
6. *Cephalhæmatoma*, in infants only; mostly over parietal bone.
7. *Abscess*, either (a) in substance of scalp; (b) beneath aponeurosis; or (c) beneath pericranium.
8. *Serous cyst*, very rare. *Hydatid cyst* of bone.
9. *Certain sebaceous and dermoid cysts*, whose contents have softened, may appear to contain fluid.

D. SOLID TUMORS.

- | | |
|---|--------------------------|
| 10. <i>Exostosis</i> , | } deeply seated. |
| 11. <i>Sarcoma and carcinoma of bone</i> , | |
| 12. <i>Dermoid cyst</i> , contents often fluid, | |
| 13. <i>Papilloma</i> , | } in substance of scalp. |
| 14. <i>Common sebaceous cyst</i> , contents often more or less fluid, | |
| 15. <i>Sarcoma of scalp</i> , | |
| 16. <i>Solid congenital tumor of scalp</i> , | |
| 17. <i>Lipoma</i> . | |
| 18. <i>Fibroma</i> . | |
| 19. <i>Osteoma</i> of scalp (?). | |
| 20. <i>Gumma</i> . | |

It must be noted that certain of the tumors in Class I., viz., *fungus of the dura mater* and *meningocele*, may cease to present any evidence of communication with the cranial cavity, and that certain tumors in Class II., viz., *certain sarcomata of the bone*, that have perforated, and *some dermoid cysts*, may acquire some of the signs that are considered to indicate origin from within the cranial cavity.

INJURIES AND DISEASES OF THE NECK.

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SURGICAL ANATOMY OF THE NECK.

THE many important structures which exist in the neck give great surgical interest to its affections. It is true that there are few organs which exclusively belong to this region. The most important structures merely pass through it from the head to the trunk. From the vertebral column with the spinal cord behind, to the windpipe in front, there are a vast number of different tissues packed into the small compass which is included under the term "neck." It is this combination of important bloodvessels and nerves, air and food passages, muscles, lymphatic and other glands, cellular tissue and fascia, which gives special interest to the surgical maladies of this region. The spinal cord, behind, is well protected by its bony case, but in front and on the sides of the neck, lie structures of the greatest importance and delicacy, which are liable to injury by accident or design.

The neck varies considerably in different persons, in both shape and length. This is mostly due to original conformation and development, but its appearance alters in no small degree, in the same person, with age, state of health, and obesity. Fat fills the hollows in females and in children more than in most adult males, so that the landmarks which define the relations of parts are in them more obscured. Among males, again, the cartilages and muscles have more prominence in some than in others. Persons with high shoulders appear to have unnaturally short necks ; and the surgeon may by position so stretch the anterior and lateral surfaces as not only to render them more tense, and thus better prepared for an operation, but also to elongate the part to a considerable degree. The great mobility and rapid movements of the head, and the quickness with which the shoulder is raised on a menace of danger, so conceal the neck as to prove a powerful protection to its structures.

It is unnecessary here to dwell in any detail on the different divisions or regions of the neck which are recognized by anatomists. Suffice it to say that its boundaries are, superiorly, the line of the lower jaw, the mastoid process, and the superior occipital line to the external occipital protuberance. Inferiorly, a line from the centre of the sternum, passing along the clavicle by the acromion, to the spinous process of the seventh cervical vertebra behind. Anteriorly, the middle line of the neck, and posteriorly, the centre line from the occipital protuberance to the spinous process of the seventh cervical vertebra, complete the definition of either side. A lateral view, when the parts are put on the stretch by turning the head to the opposite side, is somewhat quadrilateral, and, being divided diagonally by the sterno-mastoid,

is usually described as forming two triangles. The sterno-mastoid muscle being easily found, and having a close relationship to some of the most important structures, is always a leading guide to the surgeon.

There are a few points connected with the anatomy of the neck which it is desirable to epitomize as shortly as possible. Their direct bearing on many surgical affections renders a clear comprehension of them essential.

The *fascia* of the neck are among the most important of its structures. They inclose, fix, divide, and yet bind together, the various tissues and organs. The most superficial layer is continuous with that of the chest and head, and incloses in its folds various muscles, bloodvessels, and nerves. Attached at various points to bone (jaw, cranium, vertebrae, sternum, clavicle, and ribs), the cervical fascia gives firm support to the structures it incloses. Important septa pass inwards from the deep layer to be attached to the transverse processes of the cervical vertebrae, from the second to the seventh, and to the two first ribs. These, besides inclosing the roots of the cervical and brachial nerves, divide the deep portion of the sides of the neck into an anterior (larger) and a posterior region. In each of these compartments, again, each muscle has its sheath, while the great vessels, together with the trachea and oesophagus, are effectively inclosed. From this arrangement both good and harm may arise. Fluid collections, diffuse inflammation, and even new growths, make their way more readily downwards, towards the chest, than either upwards or to the side, and thus a source of much difficulty and anxiety is occasioned to the surgeon, seeing that there may be much obscurity as to the origin and relations of such affections. Growths, etc., lying above the deep fascia are readily dealt with, while those placed below it are often beyond interference. The movability of tumors, though capable of occasioning deception as to their connections, is, as a rule, a most valuable guide regarding their relation to this deep fascia. This character, together with the possibility or not of raising them, so as, as it were, to insert the fingers below them, always commands the surgeon's attention when considering the possibility of an operation for their removal.

A triangular portion of the middle layer of the cervical fascia, to which Richet has given the name of "omo-clavicular aponeurosis," has been credited by that author with the important office of keeping the great veins of the neck open, and so facilitating the return of blood from the head. This structure has its base below, and its apex at the hyoid bone. It lies on either side of the middle line, and to its outer sides the omo-hyoid muscles are attached. These muscles render the fascia tense, and in this way produce the effect above mentioned. The infra-hyoid muscles, the thyroid plexus of veins, together with the lower portion of the jugulars and the other great venous trunks at the root of the neck, being attached to offsets from it, are all powerfully influenced by its degree of tension. The risk of air gaining admission into these vessels when wounded in this dangerous region, is, however, much enhanced by the same mechanism. Fluid forming underneath the fascia, will, of course, be directed with facility into the axillae or mediastina.

With the middle line of the neck the surgeon is often occupied, and with its anatomy he should be well acquainted. Below the symphysis we have the *supra-hyoid* space, which, if opened, will give access to the cavity of the mouth and to the tongue. A longitudinal incision in the middle line will, however, wound no structures of any consequence external to the mouth. Through such an incision Chassaignac passed the chain of the *écraseur*, in order to divide the tongue; and Regnoli, making a semicircular incision extending along the border of the jaw, drew the tongue down through the opening, and was thus able to excise its anterior half. Close below the jaw lies a lymphatic gland, which occasionally inflames and suppurates, and if

not opened may leave an ugly mark. Sebaceous cysts are also met with in this region, and may attain so considerable a size as to project in the floor of the mouth, as well as below the jaw. Hydatid cysts have also occasionally been seen here. Ranula, when large, may cause considerable bulging in the supra-hyoid region. It is not always easy to recognize small fluid collections in this part of the neck, from the softness and pliancy of the structures. By pressing the finger into the floor of the mouth, close behind the symphysis, the parts will be steadied and the presence of the fluid more easily distinguished. The *hyoid bone*, though buried in the tissues, is easily recognized by its resistance and horse-shoe shape. From its floating so much it is displaced with facility. The cornua, passing outwards and backwards, serve as important guides to the surgeon in seeking for the lingual arteries. The *submaxillary* and *sublingual glands*, with the surrounding lymphatic glands, the lingual, sublingual, facial, and submental bloodvessels, together with the lingual, hypoglossal, and other nerves, lie in the supra-hyoid region. The *hyo-thyroid membrane*, with the small superior laryngeal artery (a branch of the superior thyroid, of the external carotid) and nerve upon it, comes next. A wound in this region might implicate the epiglottis. The upper part of the larynx may be reached by an operation, suggested by Vidal and Malgaigne, for gaining access to abscesses in the glosso-epiglottidean folds, or to polypi or foreign bodies not otherwise accessible.

A *bursa* lies on the anterior surface of the thyro-hyoid membrane, and passes under the hyoid bone. If this bursa enlarges, it will give rise to a small, tense, fluctuating and chronic tumor, which may finally end in a fistula. The "*pomum Adami*," below this, with its notch at the point of union of its wings, is a well-known landmark on the front of the neck. The projection of this cartilage varies in different persons, and is more pronounced in males than in females. By keeping the notch in line with the chin and the supra-sternal hollow, the middle line of the neck is easily retained. The thyroid cartilage ossifies comparatively early in some persons. It can be divided with safety in the middle line, for the removal of foreign bodies, growths, etc., but of course any deviation from the central line will cause risk to the vocal cords. A small, serous, subcutaneous bursa lies in front of the thyroid cartilage.

Below the thyroid cartilage comes the *crico-thyroid membrane*. It is slightly depressed, and has a minute artery distributed to it. In this membrane the operation of laryngotomy is performed. Next comes the ring-like *cricoid cartilage*, which is readily distinguished by its greater firmness and resistance. It corresponds in level to the sixth cervical vertebra, and is of great interest to the surgeon in connection with tracheotomy, laryngo-tracheotomy, ligature of the common carotid, œsophagotomy, operations on the thyroid body, etc. At the level of this cartilage also, the pharynx becomes œsophagus, and is at the point of junction so narrow as to be liable to arrest the passage of foreign bodies and instruments. The *carotid tubercle* on the transverse process of the sixth cervical vertebra, against which the carotid artery can be compressed, is found to the side of and below the cricoid cartilage.

After the cricoid, comes the *trachea*, with the *isthmus of the thyroid gland* covering the second, third, and fourth of its rings. The breadth of this connecting bridge varies very much in different cases, being usually broader and more developed in females. In thin persons, the upper rings of the trachea can be traced when the finger is pressed over them. The thyroid lobes, lying upon either side, are not easily distinguished unless enlarged. They rise and fall with the windpipe, and, when increased in size, the superior thyroid arteries can be felt pulsating on their upper and anterior surfaces.

When there is great hypertrophy or other enlargement of the thyroid bodies, the isthmus may cover the whole of the front of the windpipe, and form a pyramidal body, ascending even to the hyoid bone.

Compression of the windpipe, and impeded flow of blood, both in the veins and arteries of the neck, may be produced by the mechanical pressure of the thyroid lobes and isthmus, and so disturbance within the cranium may follow. When enlarged, the bloodvessels in the isthmus may become formidable and dangerous to wound.

The trachea gets deeper and deeper as it descends to the chest, and in fat persons may, as it passes behind the sternum, be an inch and a half distant from the surface.

The *thymus* may present itself in young children as a considerable tumor in the supra-sternal notch. In exceptional cases it has been known to rise high up in front of the neck.¹

Lymphatic glands, the first of the bronchial chain, also lie above the notch. They occasionally enlarge and suppurate profusely, in young, delicate persons, and as a pulsation is communicated to the abscess by the great vessels which lie close to it, such a swelling has been mistaken for aneurism of the arch of the aorta. A deep and unsightly scar is often left after the healing of such suppurations. If these glands become much enlarged, they may by their pressure produce "false croup."

The distance between the top of the sternum and the vertebral column, is on an average two inches; that between the cricoid and the sternum, when the neck is in its usual position, is about an inch and a half; but in paroxysms of dyspnoea, these two points may be closely approximated.

In front of the trachea, arranged chiefly in a longitudinal direction, lie the *thyroid veins*, and, it may be, an *anterior jugular vein*. Numerous lymphatic glands also exist close to the windpipe. Behind the thyroid veins lies, in those unusual cases in which it exists, the *middle thyroid artery*, first described by Neubauer. Originating from the aorta, it passes straight up in front of the trachea to the isthmus, and would of course cause a complication in tracheotomy.

The *œsophagus*, at first placed behind the larynx, comes to be deflected to the left side so that it can be opened clear of the windpipe. Deep in the groove between the trachea and œsophagus, on either side, lie the *recurrent laryngeal nerves*. They are not disturbed when the œsophagus is reached by Nélaton's method of keeping close to the trachea in order to avoid the carotids. It may be here noted that neither the shape, consistence, color, nor movements during deglutition, form reliable guides to the œsophagus when it is to be opened on the living subject. It is only by feeling for the foreign body (if one be present), or better still, by passing down a sound from the mouth, that confidence and safety in opening the gullet can be insured.

Both the superficial and deep layers of the cervical fascia meet in the middle line of the neck, but the platysmas (which are inclosed in the fascia) only do so at the upper part. The pre-tracheal muscles lie on either side of the middle line, and are united by the aponeurosis which crosses over it. The windpipe and œsophagus are very movable, both laterally and vertically, in consequence of the loose bed of cellular tissue in which they lie. This freedom of motion is essential to their function, but it increases the difficulty of the operator in dealing with them. The sheath of fascia which incloses the trachea and œsophagus, accompanies them into the chest, so that pus getting access to its interior may pass into the mediastinum. The writer has known a post-pharyngeal abscess to cause death by bursting into the chest.

¹ Allan Burns, *Observations on the Surgical Anatomy of the Head and Neck*, 2d ed. Glasgow, 1824.

This sheath is connected on either side with that of the great bloodvessels, and in front with the omo-clavicular aponeurosis before alluded to. From all that has been said, it is apparent that tracheotomy may become one of the most difficult and anxious operations, especially in young children with short fat necks, who have had sinapisms and poultices applied, and in whom the veins are distended from impeded respiration, especially if the thymus be also enlarged.

From the tenor of what has been said, it may be inferred that the middle line of the neck, from the chin to the sternum, is the safest place for incisions to be made. The structures become more and more dangerous to interfere with, as we diverge on either side. In all cases in which it is possible, deep abscesses lying near the middle line are best got at by an incision in the centre, followed by the use of dressing forceps inserted along the groove of a director, as recommended by Mr. Hilton. Other positions in which incisions can be made with safety, are along the line of the lower jaw and behind the sterno-mastoid, where, too, the director and forceps should be employed for completing the deeper parts of the incision.

Finally, the space which intervenes between the posterior edge of the *sterno-mastoid* and the anterior limit of the *trapezius*, is of much interest to the surgeon. It varies considerably in extent according to the development of these muscles. The posterior belly of the *omo-hyoid* can, in thin persons, be seen like a cord running athwart the neck, nearly parallel to the clavicle. The pulsations of the *subclavian artery* can also be detected close to the external edge of the sterno-mastoid, which edge again closely corresponds to the outer border of the *scalenus*, the first guide to the ligature of the subclavian in the third part of its course. The artery can be here compressed by the thumb (the surgeon standing behind the patient), or by a padded key-handle or roller-bandage pressed downwards and somewhat inwards, so as to bear directly on the tubercle of Lisfranc. Lastly, the *external jugular vein* is visible in many people between the sterno-mastoid and trapezius.

As was before remarked, the neck escapes injury in a remarkable manner through the great protection afforded it by the head and shoulder. Yet contusions and wounds (homicidal and suicidal), burns, and morbid growths of various kinds, have to be dealt with. In the following remarks, injuries of the spine are not considered, nor are affections of the larynx, trachea, and œsophagus; nor yet the affections and operations connected with the great vessels of the neck, these subjects being all discussed in other articles.

CONTUSIONS OF THE NECK.

Contusions of the neck, if violent, may cause insensibility, and even death, from shock or spasm. The hyoid bone, or the laryngeal cartilages, may be broken or crushed. It is well known that these structures may be seriously injured by the grasp of a garroter, or by the rope in hanging, or by the passage of a wheel, or by a fall on a pointed body. A violent blow with the fist alone may very seriously injure the larynx, and be followed by dangerous symptoms.¹

Fractures of the hyoid may implicate the body or the wings. The fragments may be displaced, or not. This accident is said to have been caused by muscular action alone. (Ollivier.) The fragments may project so as to cause a visible deformity. The *cartilages* may be driven inwards or to one

¹ Lalesque, Jour. Hebdomad., Mars, 1833; Auberge, Revue Médicale, Juillet, 1835; Orfila, Médecine Légale.

side. They have been driven through the mucous membrane, and have occasioned severe bleeding. Much bruising, swelling, and pain accompany these accidents, and all movements of the parts or of the tongue, as in articulation or deglutition, become both difficult and painful. The *trachea* has been ruptured and yet no wound has existed externally. (Bryant.)

An attempt by manipulation may be made, under chloroform, to restore any displaced fragments, but such measures are difficult and seldom succeed. If replaced, they may be secured by adhesive plaster, or by fixing the head on a pillow, with the neck straight or bent according as the parts are found most relaxed. Easily swallowed food should alone be given, and it may be necessary to use the stomach-pump for alimentation. If there be much laceration, it will be almost impossible to retain the fragments in place. Tracheotomy may be required if there is a threatening of asphyxia, and artificial respiration may be needed to overcome the immediate danger. If an accumulation of air or blood in the cellular tissue cause injurious pressure, an incision in the middle line may be necessary.

It has been alleged that the *hyoid bone* may be *dislocated*,¹ but this observation is far from being confirmed.

Fracture of the cricoid is a very dangerous accident. It implies much violence, gives rise to shock, convulsive cough, and spasm, and is apt to be followed by such severe inflammation and swelling as to render it generally fatal. Mr. Durham gives a summary of recorded cases from Hénoque and others. He mentions sixty-two cases in all, of fracture of the bones and cartilages of the larynx, with only twelve recoveries.²

Necrosis may attack the cartilages of the larynx as a result of injury, but more usually it is due to syphilis. Much local and constitutional disturbance is thereby occasioned. Though this disease is usually chronic in its course, yet acute symptoms may arise at any time and induce the utmost danger. The portions of dead cartilage may be discharged with the profuse and offensive expectoration, or may cause abscesses which, after dissecting their way far and near, may allow the *débris* to escape externally. Fistulæ may thus be established, and a cachexia which is severe and difficult to deal with. All such pus-collections should be opened as early as possible, their drainage secured, and any dead and detached pieces of cartilage removed. Bronchotomy may be required at any time to relieve spasm and œdema, and this measure may be rendered desirable even to secure rest to the diseased parts, and to give time for the employment of constitutional remedies, or local applications, such as medicated air, etc.

The sterno-mastoid muscle may become the seat of swelling and effusion, from being strained at birth (*congenital tumor or induration*³), and one form of wryneck may be due to this cause. Violent twists of the head, falls, and even rapid and strong contraction of the fibres of this muscle, have been known to cause partial rupture in the adult, followed by sudden and distressing pain, together with considerable effusion, necessitating rest, fixation, and fomentations, with subsequent friction, for its removal.⁴

BURNS AND SCALDS OF THE NECK.

Scalds and burns are not uncommon in the neck, and, if severe, are attended with serious shock. They occasion much anxiety subsequently from the

¹ Gibb, *The Hyoid Bone*. London, 1862.

² See Holmes's *System of Surgery*, 2d ed., vol. ii. p. 462.

³ See Myo-sclerosis, page 196, *infra*.

⁴ *Revue des Sciences Médicales*, tome ii. p. 741. 1873.

inflammation and effusion which are apt to occur within the larynx, together with the contraction and deformity which may follow. (See Volume I., pages 715, 723, 739.)

WOUNDS OF THE NECK.

Wounds of all kinds have to be treated in the neck, and though in their general features they do not differ from similar injuries in other parts, yet from the mode of their infliction—being for the most part homicidal or suicidal—from the structures usually involved, as well as from the severe and dangerous complications which may follow, they are especially important and interesting. Many of these lesions are fully dealt with in other portions of this work. In the present article they can be considered but generally and concisely.

Suicide by cutting the throat is more commonly attempted in Great Britain than elsewhere, in proportion to other modes of self-destruction. Homicidal wounds of the neck are also not infrequent. All sorts of weapons have been used, and every degree of injury and very various complications have had to be dealt with. That wounds of the neck are frequently seen in military practice, is shown in the official reports of the recent European and American wars. Foreign bodies, too, may be buried and lost in the tissues of the neck.

Wounds of the neck may be superficial, and uncomplicated by the lesion of any important structure; or deep (that is, penetrating the fascia), and then they usually involve bloodvessels and nerves of importance. There may be a very extensive division of the soft parts, and yet the windpipe and great vessels may escape; while with a small, external wound, there may be serious, deep injury, the exact nature of which may be difficult to ascertain. It is by considering the nature of the weapon which has inflicted the wound; the direction and depth of its penetration; the clothing of the parts at the time; the nature of what escapes (air, arterial or venous blood, food, or mucus); the effects on the function of the larynx, lungs, cesophagus, and nerves; the occurrence or not of emphysema; and also, in case of an assault, by taking into account the relative position of the assailant to the sufferer, that a judgment is to be formed. In gunshot-wounds, it is seldom that the modern bullet is deflected from its course as the old round ball used to be, but even the conical ball, if much spent and travelling at a low rate of speed, may take a devious and unexpected course in the neck. Large, open wounds are of course easily judged of, as they admit of being examined by the eye and finger.

The *external jugular vein*, from its superficial position, may be injured in comparatively shallow wounds. Pressure will often arrest the bleeding. If not, the vessel should be tied on both sides of the wound. The entrance of air might, of course, prove a serious danger.

Wounds of the *thyroid body* may prove very dangerous from bleeding.

The lips of transverse wounds of the neck gape much, but those of longitudinal wounds, such as are made by the surgeon, seldom do so. The elasticity of the skin and the action of the platysma usually cause the lips of transverse wounds to curl inwards, and it is in order to secure their more accurate apposition that sutures have been advised in their treatment. The risk of the drainage proving insufficient, and so causing diffuse inflammation and the burrowing of pus, is, in the experience of many, a stronger argument against their use. In most cases, however, the surgeon will be enabled to employ sutures without inducing harm. The most ample provision for drainage is essential, and to secure this it may be requisite to make a longitudinal incision at the

centre or other appropriate part of a transverse wound, and not to close the more dependent part under any circumstances as long as there is any discharge. If sutures are used, they should be placed close to the edge of the wound; and adhesive plaster, with careful position, should be employed to support the stitches and keep the platysma at rest. The sutures may be of catgut, horse-hair, or wire, as is thought most appropriate, and antiseptic dressings can be perfectly adapted to superficial wounds, though primary union is not usually got throughout, however desirable it may be to obtain it. The appearance of swelling or erythema, or any evidence of pressure, will make it necessary to remove the sutures partially or completely.

Wounds of the neck which involve the *air-passages*, *great vessels*, and *nerves*, are of course extremely dangerous, and often rapidly fatal. The air-passages alone are not uncommonly involved. The suicide, as has been often remarked, frequently fails in his purpose by cutting high and throwing his head too far backwards. In this position the windpipe is advanced, and the carotids are covered by the sterno-mastoids, which become tense. When, on the other hand, the wound is inflicted lower down, the resistance of the laryngeal and tracheal cartilages, the spasmodic contraction of the sterno-mastoid muscles, and the greater depth at which the carotids lie, frequently save those vessels from being wounded. Mr. Hilton suggests that when the air-passages are opened below the glottis, and air escapes from the lungs, the muscles connecting the chest and arms are so weakened as to diminish their power of action. The carotid arteries have been laid bare by the suicide, and yet not opened, and well-authenticated cases have been recorded in which both the trachea and œsophagus have been wholly divided, and yet both the carotids and jugulars have escaped. Very free bleeding may attend wounds of the forepart of the neck, and prove highly dangerous to weak patients, even although the great bloodvessels be not wounded. There are also many irregularities and abnormalities in the size and distribution of the blood-vessels in this region, which may render wounds especially dangerous.

If the *carotids* are wounded, rapid death will probably ensue, unless fainting occur and give time for surgical aid, or the irregularity and narrowness of the wound prevent the rapid escape of blood. No doubt, if skilled help were at hand, death might in some cases be warded off by pressure, followed by ligature of both ends of the artery, or by ligaturing the lower end and compressing the upper, as may be seen in cases related by Larrey and Hodgson. The former has recorded instances in which the ligature of the main vessel on the proximal side alone, succeeded in arresting hemorrhage, but this must always prove a most unsafe proceeding, and that it fails in practice is shown by the cases related by Breschet in his notes to Hodgson. Compression can with some success be applied to the common carotid, but as there is no firm point of support behind the external and internal carotids, there is little use in attempting it in wounds of these vessels.

Wounds of the *great veins* of the neck are particularly dangerous, not only from hemorrhage but from the risk of admission of air. The free anastomosis between these vessels greatly favors bleeding. The occlusion of one of the jugulars is not without danger from inflammation occurring within it, and also from the disturbance which follows in the circulation within the head. It is in the later stages of the operation of excising growths that the jugulars are most apt to be wounded, when the tumor is drawn forwards in order to divide its posterior connections, and any adherent veins are in this way put upon the stretch. A part of the vein may be thus excised, and air may rush in with an audible sound, rapidly occasioning the utmost danger. I have twice witnessed this accident, but the danger in each case was overcome by rapidly applying pressure, followed by ligature of

the wounded vessel. The hissing, sucking, or whistling sound, as it has been variously described, is quite peculiar and distinctive, while the sudden blanching of the face and tumultuous action of the heart which follow, but too surely indicate what has occurred. Such an occurrence may follow wounds of any of the great veins in the "dangerous region" at the root of the neck, but it has been most often seen in the jugular, subclavian, and axillary veins. A large opening is not necessary. Erichsen¹ relates a case in which entrance of air took place, and was followed by death, during the passage of a seton into the forepart of the neck, and Le Gros Clark has shown that the air may be so slowly drawn in by the orifice of a half-divided, small vein, as not to evidence itself at the wound by the usual signs.² In narrow wounds, where the opening in the vein and that in the soft parts have lost their parallelism, the neck may be extensively infiltrated.

Pressure should in all such accidents be at once applied, till the vein is tied above and below the wound. It is better to tie the vessel completely, even though its calibre be but partially divided, rather than pick up the orifice alone in the hope of not obstructing the vessel, as was at one time recommended. In an elaborate study of the subject, Professor S. W. Gross has with his usual ability dealt with these lesions of the great veins.³

When the *thyroid body* is wounded the bleeding may be very profuse, and difficult to arrest from the very free anastomosis which exists between its vessels. Both arteries and veins bleed violently, the veins especially, if the respiration is embarrassed. To tie these vessels is very difficult, and pressure cannot be borne. In some cases it might be possible to pass a needle under the bleeding point and apply the twisted suture.

The various *nerves* of the neck, especially those connected with the arm, may be involved in wounds. Bullets have frequently injured the cervical nerves, and paralysis with wasting has followed. The pneumogastric and phrenic nerves may also be cut, when the carotids are divided, and bullets have occasionally injured both these nerves as well as the sympathetic, though few such cases have been described in detail.

The most common position for suicidal and homicidal wounds has been made the subject of statistical inquiry. They have been most commonly seen at or about the thyro-hyoid membrane, or a little below it.⁴ In assaults, the chin being depressed has protected the upper part of the throat. Gunshot wounds may, however, occur anywhere, and portions of the throat may be in them even torn away. Wounds in the supra-hyoid region may open the cavity of the mouth, wound the root of the tongue, and partially or even wholly detach the epiglottis. Suffocation may be caused by the entrance of blood or other matters into the air-passage, or by the epiglottis or the tongue occluding its orifice. Swelling and œdema, which usually follow, may also occasion danger. The facial and lingual arteries with the hypoglossal and other nerves, may be injured in such high wounds, and fatal bleeding may follow if efficient surgical aid cannot be obtained. These vessels can, however, be readily ligatured. In wounds lower down, besides the windpipe, the arytenoid cartilages and vocal cords, and the aryteno-epiglottidean folds, may be involved, with the lingual and superior thyroid arteries, the superior laryngeal nerves, and even the carotids.

¹ Science and Art of Surgery, 5th ed., vol. i. p. 418.

² Lectures on the Principles of Surgical Diagnosis, etc., p. 225. London, 1870.

³ American Journal of the Medical Sciences, 1867.

⁴ Durham, in Holmes's System of Surgery, gives a summary of 158 unselected cases, from which it would appear that 45 of the wounds were through the thyro-hyoid membrane, 35 through the thyroid cartilage, 26 through the crico-thyroid membrane or cricoid cartilage, 41 into the trachea, and only 11 above the hyoid bone. Horteloup and Sarazin have also published statistics upon this point, but the teaching from these figures is of little moment.

When the *epiglottis* is divided, besides the danger of suffocation, the speech, respiration, and deglutition, will be affected, and the latter perhaps rendered impossible by spasmodic cough. A wound in this region gapes more or less, and the food (especially liquids) will probably escape. If the thyroid vessels, jugular veins, and thyroid body are involved, the hemorrhage will be very profuse and probably fatal. The recurrent laryngeal nerves may also be implicated. Thirst is a frequent, though not universal, complaint in these wounds, and there is great risk of serious complications such as diffuse cellulitis, producing great swelling and œdema, and attended with great constitutional disturbance. The edges of incised wounds are often very irregular, from the skin not having been stretched at the time it was cut. Suicidal wounds are especially apt to be attended by serious complications, on account of the state of health of the patients who are their subjects. Such wounds are frequently inflicted during a period of temporary insanity caused by intemperance, when the whole system is out of order.

The *air-passages* have been wounded in every possible way, and with wounds of the most diverse descriptions. Every species of wound has been met with, and foreign bodies of many sorts have been driven in from without. The records of surgery supply a curious collection of such accidents. The surgeon makes his incisions in the axis of the windpipe, but homicidal and suicidal wounds are usually more or less transverse.

Suicides sometimes so hack and cut the throat that portions of the cartilages may be wholly detached and removed, as occurred in an extreme degree in a case under my own care. These wounds may be very irregular, and attended with much laceration of the soft parts. If the larynx or trachea are only partially divided, the wound will not gape much, but if the division be complete (which is not common), the separation of the lips may be very considerable.

The *œsophagus* may be severed as well as the air-tube, by one stroke of the knife. I saw this lesion in the case of an intemperate surgeon who committed suicide, and who, from notes found among his papers, had evidently studied the subject carefully. The whole of the tissues on both sides of the neck, including the great bloodvessels, were divided, and even the spinal column was marked by the blade of a long, sharp amputating knife which he had used. When the wound is sufficiently deep to implicate the air-passages, the complications which may occur early or late are gaping, bleeding (which will vary with the direction and extent of the wound), and the escape of air and mucus, and possibly of alimentary matters, if the wound be high in the neck. Aphonia and various alterations of the voice, together with difficulty of breathing and emphysema, may also be present. The latter condition will appear when the orifice is so narrow as to allow the air more readily to penetrate the cellular tissue than to escape externally, and in that case it may possibly extend far and wide, especially downwards along the trachea and œsophagus into the mediastinum, and, according to Horteloup, it may even reach the scrotum. Death will be rapid if the great bloodvessels are largely opened, but when the wound is small, life may be saved by fainting. Secondary hemorrhage, days or weeks afterwards, may end life.

Effusion into the glottis and cellular tissue is one of the menacing dangers, especially in narrow wounds. The whole interior of the air-passages, from the glottis to the minute divisions of the bronchial tubes, may become involved, as well as the substance of the lung itself. This may be due to the mere extension of the inflammation, or to the admission of cold air, or of foreign bodies. Suppuration too may eventually arise at the wound, and pus may dissect its way far and near in the cellular tissue of the neck. If recovery from these conditions follows, permanent contraction of the air-passages, with

aphonia and fistulous orifices, is likely to remain. There are a few instances in surgical literature of the entire obliteration of the upper part of the larynx, and that too without the entire loss of the voice. In these rare cases, the air has gained admission to the vocal cords by the external wound. Suffocation may, however, threaten, from the contraction of the passage and the adhesion to surrounding parts preventing movement. *Fistulæ* (which under ordinary circumstances are not common) are, for the most part, due to loss of substance, or to such gaping of the lips of the wound as treatment fails to counteract. They are very difficult to repair.

It may be here said that *spontaneous rupture of the trachea* during violent fits of coughing has been said to occur, but the fact is somewhat doubtful, and is of too little practical interest to be dwelt upon.

Bullets, poniards, etc., may reach the pharynx or œsophagus, either through the mouth or by the side of the neck. Jugglers have fatally wounded themselves in passing swords down their throats. Mr. White relates a remarkable case in which a navvy fell backwards upon a small, sharp pick, which penetrated his neck, and, passing between the carotid vessels, pierced the pharynx immediately behind the posterior pillar of the fauces. The man made a rapid recovery.¹ Insane persons have inflicted serious wounds on these parts through the mouth; and bougies, forceps, etc., used by surgeons, have caused laceration and rupture. Even violent vomiting is said to have ruptured what appeared to have been a sound œsophagus. Punctured wounds in which both the air-passages and œsophagus have been penetrated, are uncommon, yet in deep transverse or oblique wounds they may both be involved.

Wounds of the pharynx and œsophagus are said to occasion pain, spasm, hiccup, dysphagia, thirst, and a feeling of constriction amounting almost to suffocation. The escape of alimentary matters is not constant, and its occurrence does not necessarily show that the food-passage has been opened. If the glottis, as the result of swelling or diminution of its nerve supply, loses its sensibility, as it occasionally does in the later stages of wounds of the air-passage, it may no longer act as a barrier to the passage of foreign bodies, and thus food may gain admission into the windpipe and appear at the wound; but although the escape of alimentary matters is thus not diagnostic of a wound of the pharynx or œsophagus, yet it is in any case a serious symptom, as it implies a grave lesion.

Wounds of the *back of the neck* may either involve the soft parts alone, or penetrate into the spinal cord. In the latter case they are quickly fatal, but in the former they may be very extensive, and yet not cause death.²

The difficulty in dealing with deep and extensive flesh-wounds in the back of the neck, is to keep the head fixed in a good position and to provide effective drainage. The well-known observations of Larrey, as to atrophy of the testicle and paralysis of the lower limbs following such wounds even when the brain and cord have apparently escaped, have not been verified by more recent experience.

In France, it is said that infanticide is occasionally accomplished by inserting a needle between the axis and atlas, a mode of murder very difficult to detect.

The *prognosis* of such wounds of the neck as are not rapidly fatal, is not always easy. The part wounded and the depth of the lesion are often more important than its extent; but the opinion formed of the result will in all

¹ British Medical Journal, vol. ii. p. 146. 1876.

² See Legouest, *Traité de Chirurgie d'Armée*; Surgical History of the War of the Rebellion; and the author's Notes on the Surgery of the War in the Crimea.

probability chiefly turn on the complications which may exist. All wounds in this region are of course liable to the same accidents as similar injuries elsewhere, but they have, besides, special dangers of their own, and even slight wounds may become the source of the utmost anxiety. Inflammation followed by extensive and rapid effusion may arise at any time and occasion the utmost danger. The great risk is interference with the breathing, and it has been shown how many conditions may cause this either early or late. Small wounds of the air-passages are sometimes more dangerous than large ones, from imperfect drainage.

The weak and irritable condition so often present in suicides, insane persons, and the old, renders their wounds more liable to complications. Persons suffering from delirium tremens, as is well known, are peculiarly apt to suffer from low inflammation and rapid exhaustion. That, however, there is always hope of recovery even in the most desperate cases, is amply shown by the records of surgery. Many instances exist of recovery following the most extensive, and, at first sight, hopeless-looking wounds, and this sometimes in most unpromising patients. When the bleeding can be stayed and the breathing kept free, we need never despair.

As to the *treatment* of wounds of the neck, it is manifest that the leading indications are to command the bleeding, secure free respiration, and overcome shock. To accomplish these ends, the same measures are employed here as in other wounds, and do not call for detailed remark. If, in order to fulfil these purposes, it be requisite to enlarge the original wound, the surgeon must not hesitate. To secure all the wounded bloodvessels may not be easy, and requires much precious time. A ligature should be applied to both ends of divided vessels, and upon either side of punctured wounds. In narrow, deep wounds, the difficulty of carrying this out is very great. Pressure is almost impossible to apply effectively, even in superficial wounds. Pressure-forceps, if quickly applied, will, however, be of much service by giving time for the application of ligatures.

The entrance of blood into the windpipe must be carefully prevented, and if necessary a large tracheal tube must be inserted, and the space round it closed by plugging. The trickling of blood into the air-passages will, in a weak or fainting patient, readily occasion slow and insidious suffocation. Hemorrhage from small veins is best arrested by keeping the respiration free. Other sources of embarrassed respiration, such as the semi-detached tongue, or epiglottis, or cartilage, must be attended to.

If dangerous emphysema arise, it may be necessary to enlarge small and narrow wounds; but otherwise, unless there be bleeding or deficient drainage, they are best left alone.

The use of sutures in wounds of the throat, has given rise to much controversy. Their careless employment has occasioned so much harm as to have led to their general condemnation. Modern surgery, however, does not so rigidly exclude their use in all cases as was done some years ago. It is true, and cannot be too strongly insisted on, that if the breathing, or drainage, be in any way obstructed, or emphysema caused, by their presence, then nothing but harm and danger can come from their use. Good and not evil will, however, follow by approximating the lips at the ends of long wounds by a few stitches, so as to counteract the great gaping, and this will be the more necessary if the trachea be entirely divided, and if it retract much, as it is apt to do. It is seldom that the larynx or trachea themselves require to be stitched, and when that has been attempted, good results have rarely followed. It is the centre of the external wound which it is of most consequence to leave open, and if at any time indications of deficient drainage or imprisoned air appear, any stitches which have been introduced should be removed. The

head should be fixed in such a position as may promote the approximation of the lips of the wound, and relieve tension, while not interfering with the escape of discharges. There are various methods of accomplishing this. Putting a night-cap on the head, and attaching it to a body band by tapes, while the head and shoulders are raised, serves the purpose in most cases. All speaking and movement, as in swallowing, should as much as possible be avoided, and watchful nursing is essential, especially in suicidal cases.

Sutures may be used to unite wounds of the œsophagus, if position fail to approximate the divided parts. Drainage must of course, in all cases, be carefully secured. In the early stages of treatment, deglutition should be avoided as much as possible, and for this purpose we must resort to the use of carefully prepared enemata. A tube may be passed into the stomach either by the wound or by the mouth, but as soon as cicatrization has begun the former method must be avoided. In any case it is bad practice to leave the tube in place, and if its passage cause much inconvenience, enemata must alone be relied on. Legouest suggests a method of passing the œsophageal tube by first introducing a small urethral bougie by the wound into the lower end of the œsophagus, and attaching to its upper extremity, by means of a small sound passed from the buccal cavity downwards to the wound, a long thread which is brought out by the mouth, and then using the thread and bougie as a conductor for the œsophageal tube. During cicatrization, the calibre of the canal must be retained by a careful and judicious use of bougies.

Thirst is a serious annoyance in such cases. Small bits of ice put on the tongue relieve it, but have the disadvantage of causing frequent acts of swallowing. As soon as healing has well advanced, unirritating fluid food may be allowed. If there be much exhaustion, milk, broths, and other forms of concentrated nourishment must be administered.

The air respired should be moderately warm and moist, without being exhausting. A temperature of between 70° and 80° Fahr. suits best. The entrance of foreign bodies must be prevented by covering the wound with moistened muslin. If dyspnœa occur, its exact cause must be sought for and remedied. The base of the lungs should be frequently and minutely examined. By temporarily closing the wound, the patient will be enabled to eject fluid which he cannot otherwise get rid of. Inflammation in any part of the air-passages, lungs, or pleuræ, must be constantly watched for and promptly treated. It may come on very insidiously and spread rapidly. Edema of the glottis is a most serious complication. It may be dealt with by the usual remedies, or by introducing one of the tubes described by Dr. McEwen.

The healing of the wound must be supervised, and exuberant granulations, if they occasion obstruction, repressed by appropriate means. Restlessness and excitement may require to be combated by the subcutaneous use of morphia. Tracheotomy low down in the tube may be reasonably considered when the wound is more than usually difficult to manage, especially if signs of obstruction follow its closure. The rest thus gained will promote the healing of the wound, and the dilatation of a contraction following the cicatrization will be better managed from below than by passing instruments from the mouth. In some cases the laryngoscope may prove serviceable in dealing with such contractions. Abscesses, if they form, must be effectually drained. Schrötter proposes to render the larynx insensible by the application of a saturated solution of acetate of morphia, after having first increased the capability of absorption of the membrane by touching it repeatedly with pure chloroform. This is done the night before an operation is to be performed. An hour should elapse between the applications of the chloroform and the morphia.

ABSCESSSES OF THE NECK.

Abscesses of the neck of various kinds (acute and chronic, circumscribed and diffuse, superficial and deep) are common from the large amount of cellular tissue present in its structure.¹

Abscesses may be due to many causes, such as injuries and diseases in the soft parts, or bones, or glands; affections of the sockets of the teeth (especially the last molars), of the pharynx, œsophagus, air-passages, and thyroid body; irritation any where over the scalp, in the ear or the cavities of the face, in the tongue, etc. The most serious abscesses are perhaps those which occur in the course of low fevers. They are not infrequent during scarlet fever, measles, and smallpox. The scrofulous diathesis is always a powerful, predisposing cause. Purulent collections in the neck make themselves known by signs similar to those which appear in affections of a like kind in other parts, but they are remarkable from the great swelling, œdema, and tension, together with the embarrassment of function which they occasion.

The effects produced will vary with the position of the pus as regards the cervical aponeurosis. If it be superficial to the fascia, it will usually be circumscribed, and come quickly to the surface; but it may fill the whole side of the neck, extend to the clavicle, and even descend in front of the chest. When deep, the pressure-effects may be very serious.

Abscesses rarely form in the nape of the neck, though occasionally they arise there in connection with the glands. From being firmly bound down they occasion great pain, and take long to come to the surface. Fluctuation is not easily recognized. They should be opened early.

Inflammation of the gland below the chin may cause great swelling, invading the floor of the mouth. Mastication and deglutition are embarrassed by the pain. By pressing down the floor of the mouth with one finger, so as to steady and render tense the swelling, fluctuation can be more easily made out. The pus generally points under the chin, but it may pass backwards towards the pharynx, or downwards along the windpipe or great vessels even into the chest. Alterations of voice, and inflammation within the air-passages, may result from pus formations in front of the larynx. The sheath of the sterno-mastoid may be filled with pus so as to render its movements both painful and difficult, and one species of wryneck may arise from the contraction caused by inflammation of this muscle. The great sources, however, of cervical abscess, are the lymphatic glands so numerous in this region, and so liable to irritation. Though occasionally no explanation, unless it be a state of depressed health or cold, can be found for these glandular affections, yet as a rule, if carefully sought for, evidence will be found of irritation, somewhere in the wide circuit of the lymphatic vessels leading to these glands.

The worst form of cervical abscess arises when the cellular tissue becomes involved after injury or after scarlatina. The whole side of the neck may become one hard mass, which slowly suppurates and causes extensive destruction. Violent and fatal bleeding may follow in these cases, even days after the abscess has been opened, and constitutes one of their most serious complications. Persons of enfeebled health are most liable to these formidable affections, and their lives may be placed in great jeopardy by the pain, fever, pressure-effects, and prostration. Serious complications too may follow. Beside the pressure on the bloodvessels, nerves, air-passages, and œsophagus, there may be sloughing and ulceration, with serious and

¹ See Vol. IV., page 524 *et seq.*, for those connected with the vertebræ.

even fatal hemorrhage; diffuse inflammation, passing far and wide even to the chest and axillæ; thrombi in the great vessels, with embarrassment of the circulation in the brain and lungs; and, above all, blood-poisoning.¹

Cervical abscesses, if placed near the great vessels, may receive a transmitted pulsation which will cause the surgeon to hesitate as to their diagnosis from aneurism, especially as they cannot always be raised up or pushed aside so as to be freed from the influence of the vessel.

The distinction is to be made by observing the difference in clinical history of the two cases, and the ages at which they occur; the pulsation is not expansive, nor as distinct as in aneurism, and the swelling is less defined in its outline, and more superficial and diffused. In abscess, too, there will be signs of previous inflammation, probably involvement of several glands, and of the skin, and the existence of fluctuation. If an aneurism have burst into an abscess, then the difficulty of recognizing the true condition of affairs will be greatly increased.

Post-pharyngeal abscess will demand consideration in the article on affections of the throat.

Suppuration rarely occurs in the thyroid body, but, when it does, it manifests itself by the usual signs of local inflammation, accompanied by much constitutional disturbance. It is attended by much swelling and œdema of the neck, and the pressure-effects are considerable. The thyroid may even undergo splacelation and be destroyed, and that without necessarily producing fatal results, nor even much inconvenience from its loss.

Pus placed deeply in the neck may be very difficult to distinguish clearly. Fluctuation may not be recognizable, from the slight resistance of the surrounding parts, and from the firm way in which the pus is bound down. Elasticity alone may be present, but the œdema, diffuse redness, and pain, form important guides to diagnosis, unless the abscess be of small size and very deeply placed, when neither redness of the surface nor swelling may be marked.

Chronic abscesses of the neck are almost always of constitutional origin, or the result of degeneration of the glands, or of disease of some of the bones or cartilages. Sometimes these pus-collections are "residual," or the result of former inflammatory action which has left its products behind to remain quiescent for a time, and to recover their activity when the general health has from any cause become deteriorated. These abscesses are of very slow progress, and are important chiefly from the evidence which their appearance gives of weak, local and general conditions. They are often attended by very little disturbance. They may burst by several small openings which become either troublesome sinuses, or the starting points of ulceration which spreads and is difficult to repair. From the absence of much pain, and from the slow formation and advance of these pus-collections, they might be mistaken for cysts or other tumors; but a regard to the diathesis of the patient, the clinical history of the affection, and the probability of other abscesses of a similar nature having existed, together with a careful examination of the local condition, will indicate their character. Unhealthy children who have been exposed to bad hygienic surroundings are the most common subjects of these abscesses.

Treatment.—It will of course be most important to prevent the formation of pus, by removing, if possible, the irritation or cause, local or constitutional, upon which it depends, and by the use of such local antiphlogistics as may be required. In some cases counter-irritants, in the form of embrocations containing iodine, or even of blisters used for short periods, as recommended by

¹ Gross, Amer. Jour. Med. Sci. 1871.

Velpeau,¹ may be of use, but these are in the majority of cases more than doubtful remedies, unless it be in the later stages, to remove the chronic hardness which may remain. When pus has formed, the sooner it is evacuated the better. Its presence can only do harm, and it is best got rid of by such a free incision as may, if possible, obviate the need of repeating the operation or of using drainage tubes, or of any squeezing or handling afterwards. The abscess should be opened antiseptically, and its drainage carefully attended to. Capillary punctures can only be of use in the case of very limited collections. Their supposed advantage is the avoidance of a scar, but this is frequently illusory, and as a rule they are very unsatisfactory, and give much more annoyance by the necessity for their repetition than by any good which they can produce. The use of the aspirator, hypodermic syringe, trocar, or grooved needle, vaccination, and the introduction of setons of linen, metal, catgut, or other threads, capillary tubes, etc., are all ineffective, and are apt to cause greater subsequent evils than a free, clean cut.

Deep abscesses require careful management. The plan of opening them recommended by Mr. Hilton is a great improvement on the ordinary method. After incising the superficial and less important parts, a blunt director is carefully pushed down through the tissues, separating without cutting them; when the pus is seen to well up along the groove, a pair of dressing forceps is pushed in with the blades closed, and when within the cavity these are expanded, so as to enlarge the opening to the necessary extent. In incising the structures, if the knife be used, they should be carefully and slowly divided layer by layer, so as to allow of their being recognized as we proceed. Advantage should be taken of all natural shadings in the skin so as to reduce subsequent scarring to the last degree. Of course these abscesses should be opened at their most dependent part, and sufficiently freely to provide for drainage. Chassaignac² and more recently Professor Marshall have shown how easily and safely deep abscesses at the side of the neck, below the deep fascia, may be evacuated by an incision in the middle line in front of the trachea, and how far back we can seek for the pus by keeping close to the windpipe. Incisions may also be made behind the sterno-mastoid, as well as along the base of the lower jaw-bone. The cavity of large abscesses may have to be washed out with a weak solution of carbolic acid or iodine, but great care must be taken not to force any of the fluid so used into the cellular tissue of the neck. Sinuses too may require to be split up in order to promote their closure, and indurations may need to be got rid of by blisters, colorless iodine, or mercurial embrocations, while constitutional treatment will also in most cases be required to strengthen the system and improve the nutrient qualities of the blood.

FISTULÆ IN THE NECK.

Cervical fistulæ may be either congenital or acquired.

1. CONGENITAL FISTULÆ, called "branchial" by Heusinger, were erroneously called tracheal fistulæ by Dzondi, who first drew attention to them in 1829. Ascherson³ first ascribed the affection to its true cause, viz., an arrest of development in the closure of the pharyngeal fissure or cleft. The closure of the branchial arches, which terminates about the end of the second month of foetal life, will, as is well known, if arrested, give rise to various con-

¹ Gaz. Méd., Avril, 1871.

² Gaz. des Hôpit. 1843.

³ De fistulis Colli. 1832.

genital deficiencies, of which cleft palate, hare-lip, and deformities in the ear, form a part with these fistulous orifices.¹ These fistulæ usually communicate with the pharynx, though in rare cases they are found to open into the trachea or larynx. Though usually present at birth, they have been in some cases apparently overlooked, or at least not brought under medical observation till the patient has attained adult life. They have been found in several cases to be hereditary, occurring in several generations, and, in one case, affecting five children out of eight. They have been usually seen on the right side of the neck, behind or in front of the sterno-mastoid muscle, somewhere between the thyroid cartilage and the sterno-clavicular articulation. In rare cases they have been seen as high as the angle of the jaw. More rarely they have been met with in the middle line, or on both sides, in corresponding positions. They may be complete, that is, communicating with the external surface and the pharynx, or incomplete in so far that no internal opening can be found. Authors have also spoken of such fistulæ having an internal and no external orifice, though there does not appear to be good reason for such a statement. Generally they are very small, admitting a probe with difficulty, but they have been seen large enough to permit the introduction of the point of the little finger. The external orifice is occasionally found upon a small projecting mass of granulations, or it may be concealed under a fold of the skin. A thin, viscid fluid containing epithelial cells distils from the orifice, or can be expressed from it. This discharge is occasionally puriform, and may concrete so as to close the orifice and prevent the escape of the fluid. The narrow tract is lined with membrane which occasionally is highly sensitive, and a cord-like thickening may be traced backwards along its course. The discharge from these fistulæ is augmented by deglutition, especially of warm fluids, and even by mental excitement; and it is said that menstruation in some cases causes an increased flow of the fluids as well as irritation in the orifice of the fistula. Alimentary matters are not found to escape by the orifices. The direction of the fistula may be straight, or tortuous, and generally runs toward the great cornu of the hyoid bone. When incomplete the passage may be of various lengths, and occasionally portions of cartilage or even of bone may be found attached to it, being vestiges of the branchial arches. The direction of the fistula may in many cases be shown by the passage of a probe or small sound, but from the narrowness and irregularity of the passage, and the violent cough excited, this exploration may be impossible. The injection of colored or pungent fluid may occasionally succeed in proving the communication with the pharynx, while the laryngoscope may in some cases assist the investigation.

The true nature of these fistulous openings is thus shown by their not having been preceded by any local inflammation; by their position, size, and direction; by the appearance of the external orifices, and the hard cords running upwards therefrom towards the hyoid bone, as well as by the fluid which distils from them.

These fistulæ very rarely heal spontaneously. They seldom embarrass either deglutition or respiration to any serious degree, and, as a rule, they neither demand nor admit of treatment. Injections of tincture of iodine or of solutions of nitrate of silver, and the galvanic wire, have been tried, but there is risk of bringing about closure of the external orifice only, and so doing harm by inducing an accumulation of the secretion within. Incisions are useless unless the lining membrane of the track be entirely removed, and to attempt anything of this kind in such a situation, and for so trifling an affection, would be altogether unjustifiable.

¹ See Virchow's Archiv, 1864 und 1865; also Pitha und Billroth's Handbuch, 1871; and Arch. Gén. de Méd., Janv. 1875.

2. ACCIDENTAL OR ACQUIRED FISTULÆ of the neck may be due to wounds, inflammatory action, the presence of dead bone or cartilage, etc. They may occupy any position, and involve any of the structures or organs of the neck. Pus, mucus, air, or alimentary matters, may escape from their orifices. In chronic disease of the larynx, when attended by necrosis of cartilage or bone, very troublesome fistulæ may form. Reference has, however, been already made in a previous part of this article to such affections. Suppurations of any kind in the neck, especially those connected with glands, bursæ, etc., may occasion the formation of fistulæ. The suppuration of a small serous bursal sac lying between the hyoid bone and thyroid cartilage, or of some of the small glands at the base of the tongue, may be the origin of a small but very troublesome fistula seated in front of the larynx. Injections of various kinds have been employed with but little effect, but when, which is seldom the case from the depth or direction of the fistula, it is possible to excise it along with its deep terminal extremity, its closure may be secured.

As a result of venereal ulcers, or of wounds made by the surgeon, or by accident, a small orifice may lead into the larynx or trachea. I had lately under my observation a patient in whom an opening large enough to admit the point of the little finger remained after a determined attempt at suicide, which removed a considerable portion of the cartilage. When such large fistulæ exist below the glottis, there is great risk of the upper part of the air-passage being in a great measure obliterated by contraction, and of the voice being lost. These fistulæ, unless very small, are difficult or impossible to close, and in cases where contraction has taken place above, it may not be safe to obliterate them, for fear of undue interference with respiration. Cauterization and plastic operations usually fail when the orifices are large. Many methods, however, have been tried. Nélaton employed two flaps adjusted in the same way as in his well-known operation for urethral fistulæ. Roux and Désprès have introduced other plans. Jamieson's suggestion has also been put into practice. This consists in rolling up and inserting into the pared orifice a narrow strip of tissue dissected from the neighborhood, and retaining its connection at one end. It is fixed by a needle or sutures.

Erichsen¹ describes a simple and useful method of operating: "The edges of the fistulous opening having been freely pared, and the knife passed under them for some distance so as to detach them from the subjacent parts, a vertical incision is made through the lower lip of the opening so as to split it downwards. Two points of suture are then inserted into each side of the horizontal incisions bringing their edges into contact, *but the vertical cut is left free* for discharges and mucus to drain through, and for the expired air to escape, lest emphysema occur. Unless this outlet is afforded, these fluids will burst through the sutures and destroy union of the edges."

Œsophageal fistulæ are very rare, and need not be considered.

GUNSHOT WOUNDS OF THE NECK.

Gunshot wounds of the neck are not very uncommon in war. The various campaigns which, in Europe, America, and India, have afforded extensive fields for observation within the last quarter of a century, have abundantly illustrated the pathology of these wounds, but have not added much to our knowledge regarding their management. In the records of these wars, now accessible to all, the facts are clearly set forth, but there is nothing which in this place specially calls for comment. Doubtless many of those who are

¹ Op. cit., vol. i. p. 422.

wounded in the neck die of hemorrhage on the field, but many escape in a marvellous manner, and recover from injuries which at first appear hopeless. Any of the important structures may be hurt, the windpipe and œsophagus may be perforated or carried away, in part or to a wide extent, and one or more of the great nerves, which are here so numerous and important, may be destroyed or so bruised as to fail in their function. It is in the nerves of the upper extremity that this failure is most frequently seen after gunshot wounds, but it would be altogether beyond the scope of this article to do more than refer to these lesions.

SPRAINS OF THE NECK.

Sprains of the neck causing pain on movement, especially when the head is drawn backwards, are not uncommon. It is perhaps in railway accidents that these injuries are most apt to occur. A passenger, sitting reading when a collision takes place, is thrown forward, against his opposite neighbor or on the side of the carriage, striking the crown of his head. The pain is in such cases not confined to the muscles and ligaments of the neck, but shoots into the arms, and may for a time occasion derangement or deficiency of sensation, and feebleness in motion. I have lately seen two such cases, within a few days of each other. One patient was hurt, as described, on a railway; the other was thrown on his head when hunting, his neck being bent. What was somewhat remarkable, was that the pain mostly complained of in each case was strictly confined to the distribution of the musculo-cutaneous nerve, and that it could always be aroused by bending the head on the chest, or pressing on the upper part of the neck. It did not disappear in either case for several weeks.

Sprains of the neck are to be treated by rest and fixation (sand-bags may be required), with fomentations, and afterwards anodyne embrocations. Cupping and blisters may be necessary to remove the after-effects.

BOILS AND CARBUNCLES.

The back of the neck is one of the common positions where *boils and carbuncles* appear. Occasionally they also occur on the sides and front. The pain which such affections cause when they invade the indistensible structures of the nape, is very great, and may, with the loss of sleep and want of appetite, produce dangerous weakness. Fatal results occasionally arise from blood poisoning, as the pus which forms gains ready access to the veins and sinuses of the brain; and the vertebral canal may be laid open by the destructive erosion of a carbuncle. Enormous phlegmonous masses are at times seen on the back of the neck, extending from ear to ear, and as they generally occur in persons who from habits or employment are in a depraved and depressed state of health (intemperate persons with hepatic and renal affections, especially), the danger to life is often very imminent. They demand early and decisive care, but their remedies are in all respects those used for similar affections in other regions, and which have been elsewhere described.

CICATRICES OF THE NECK.

Cicatrices may follow burns, wounds, abscesses, or ulcers of the neck, and require careful treatment on account of the unsightly appearance which they

cause. It is not, however, the uncomely look of these contractions alone which calls for the surgeon's attention, but the displacement of parts and the embarrassment of function depending thereon demand to be remedied. It is chiefly after deep burns that these deformities are met with, and in such cases the most extensive displacement may take place, the chin being drawn towards the chest, or the head twisted or held firmly in some inconvenient or ungainly position. The power and long endurance of such contractions are well known. When the lower jaw is drawn down and fixed, and the lower lip everted, the gums exposed, and the tissues swelled and livid, a most distressing appearance is produced, and if it is established early in life, and not corrected, the development of the face is so interfered with that recovery becomes impossible. Excoriations arise from the irritation of the dribbling saliva, mastication and deglutition are impaired, and even phonation and respiration are seriously hindered.

These cicatrices vary much in extent and depth, as also in color and arrangement. They may be extensively adherent, or may be attached at their ends only. They may vary in color, from white to red, or brown. Bands or cords of great firmness and tenacity, projecting more or less from the surface, and having deep hollows between, run in different directions and produce a very repulsive effect. If ulceration takes place, it is difficult or impossible to heal it.

The *treatment* of these cicatrices is always difficult, and often most unsatisfactory. Mechanical appliances, together with a careful attention to position, will achieve much during the consolidation of the cicatrization, but they are apt to be discontinued, or only carelessly applied, before that process is complete and the contractile force exhausted. By successive grafts of new skin, the healing area may be much diminished and the suppleness of the tissues increased. The healing is thus not only expedited, but the repairing tissue is rendered much more flexible and abundant, and so more capable of being stretched—a capability which should be taken full advantage of as long as the due closure of the wound is not arrested. No operation need be attempted while the contraction is active, and it is far from easy to decide when best to interfere, as each case presents special features which require consideration. When old, inodular tissue does not readily allow of meddling; it is apt to have firm and insoluble connections established, and the deformity is often great and incapable of rectification.

To allow of stretching the tissue, incisions of various kinds are employed, while to diminish its thickness and resistance, compression, and agents which are supposed to promote absorption, have been used. To get altogether rid of the objectionable material, its removal has been effected by caustics or by excision, followed by simple re-union of the bordering healthy tissues, or by replacing by a plastic operation what has been taken away.

The treatment by incision is seldom adequate to the requirements of these cases, and it is not easily applied in an effective way in the neck. Though carried out with ingenuity and skill, it has often failed. Sometimes open incisions have been made; sometimes subcutaneous; occasionally the bands have been merely divided, and at other times they have been dissected up from the parts below. Multiple, small incisions, and extensive and deep ones, have all been tried. They have been made across the bands, or in zigzag, and all that mechanical skill could suggest in the way of apparatus, to keep up extension afterwards, has been used, but in nine cases out of ten they have only led to disappointment by their inadequacy to counteract the contraction, or by the irritation, inflammation, and ulceration which the subsequent extension has induced.

When the cicatrix is limited in extent, lies in the line of the superficial muscles, and is set in supple tissue, perhaps the most satisfactory way is to

remove it entirely and unite the wound carefully by suture, taking every advantage of plaits of skin, shadows of surface, etc. A straight, linear cicatrix may thus be substituted for a raised, rough, and deformed band. In other cases the replacement of the objectionable tissue by a plastic operation is the happiest resource. In removing the old tissue, such a line of incision should be employed as will best fit the adaptation of the proposed new flap. The bed in which the flap is to lie must be very carefully prepared, and all hard tissue removed from its surface and sides. The "method by sliding" (erroneously called "the French") is that most commonly employed. Flaps must be secured from one side or both, and that in varying proportions and shapes to suit the state of the parts and the ease of adjustment; and in the fashioning, fitting, and subsequent treatment of such parts, the well understood and widely practised principles of plastic surgery must be carefully applied. Flaps have been taken to replace cicatrices on the neck, from any and all the surrounding surfaces. Thus the face, front of chest, top of shoulder, and neck itself, have all been put under contribution. Carden and Teale in England, Mütter in America, Richet and Péan in France, have all published leading cases.¹

The "Indian method," by replacement, can of course be combined with that by sliding, while incisions and skin-grafting may also help in securing the desired result. In cases of extensive deformity, part only of the surface involved should be dealt with at a time, so as not to run too much risk. Esmarch's operation for establishing a joint in the body of the bone may be called for, when the lower jaw is drawn down and fixed, and cannot be freed.

As to the use of compression, and of caustic applications, little need be said. Plates of lead, or special apparatus, have been used, in order to cause the absorption of the unduly prominent tissue, but to little purpose. Caustics and iodine cannot be used effectually without running great risk of setting up ulcerative action, and when that begins in cicatricial tissue, it is impossible to say where it will cease. I have secured very good results, in cases of slight or medium severity, by the prolonged use of colorless iodine, begun in small quantities, painted on once or twice a day with a camel's-hair brush, and desisted from on the appearance of any undue irritation. The strength and frequency of the application must be regulated by its effects, and it may have to be continued for months. I have seen no benefit in the way of improving the color, from the use of chlorine or other remedies.

TUMORS OF THE NECK.

These may be of many diverse kinds, and may present some most formidable features. Innocent or malignant in character; connected with or lying in contact with the important structures of this region; congenital or not in their origin; merely giving rise to discomfort or deformity, or rapidly menacing the life of the patient, they cannot fail to secure the attention and anxious care of the surgeon. Their superficial or deep position, and their relation to the deep cervical aponeurosis, are points of the utmost importance. Abscesses have been already spoken of. Adenoma, cystoma, angioma, lipoma, sarcoma, fibroma, myxoma, enchondroma, osteoma, papilloma, lymphoma, neuroma, epithelioma, and carcinoma, in short almost all the fluid and solid growths we are acquainted with, may be met with in some of their forms in the region of the neck. Some of these are fortunately rare, and the

¹ See *Med. Times and Gazette*, 1857; *Brit. and For. Med.-Chir. Review*, vol. xiv., and *Union Médicale*, 1868.

consideration of them need not detain us, but others are common enough, and demand detailed description. The various glandular structures here present are frequent starting points of tumors, and especially of the more formidable sorts which in this position occasionally attain a very great size.

Pneumatocele and emphysema of the cellular tissue may be passed lightly by. A pneumatocele is capable of being emptied by pressure, but reappears on forced expiration. It forms a circumscribed tumor, increasing and diminishing with the respiration. It is resonant on percussion, and soft on palpation. The lung may also be projected into the lower part of the neck so as to form a hernia. This is a very rare condition, and is irremediable.

In examining a growth of the neck, it is most desirable to determine its relationship to the deep fascia. The information thus secured will help materially to distinguish the nature of the tumor, its future effects, and the hope of removing it. When placed below that strong and firmly bound down membrane, it will as it grows induce symptoms which are very manifest and important. The consistence of such deeply placed tumors is augmented, their outline is less clear, the fingers cannot be passed under them, nor can they be raised up and isolated. The pressure which they occasion will early begin to tell, and the pressure-effects will be out of proportion to their apparent size. The influence too of the fascia will be observed in the fixed character of the growths. Any or all the organs in the neck may suffer from the pressure of a deep growth. The air-passages, the pharynx and œsophagus, the great bloodvessels, and the nerves—including the sympathetic, the recurrent, and the pneumogastric—may be thus affected. The well-known effects on the temperature and cutaneous sensibility of the face and ear, and the changes in the conjunctiva and pupil, which indicate compression of the sympathetic,¹ may be observed. The circulation through the brain too may suffer, and, in short, most serious and wide-spread effects may follow from the pressure exercised on important organs. The observation of Vidal, that the violence of the pressure in deep tumors may subside as the growth progresses, has not been verified in my own experience, though the fact that it is only in the later stages of superficial tumors—that is, when they have reached considerable dimensions—that the evidence of pressure may appear, is in keeping with what would naturally be expected.

Aneurism, spina bifida, and ranula do not lie within the range of this article, but adenitis, lymphoma, cystoma, lipoma, fibroma, enchondroma, and carcinoma will be considered, while various growths of less frequency or importance will be very shortly alluded to.

ADENITIS AND ADENOMA.—Acute inflammation of the glands has been already described. The chronic form is both common and difficult to deal with, and that chiefly from the circumstance that it may be dependent on either a local or a constitutional cause, or on both, acting in varying degrees. The subacute form of the affection is also frequently met with after depressing ailments. Irritation in some part of that enormous surface whose lymphatic vessels end in the cervical glands, is the usual, if not (as some believe) the sole cause of that enlargement which characterizes chronic adenitis. Upon the violence or acuteness of that irritation will of course greatly depend what the effect on the gland will be, whether it shall be excited to acute action, or shall slowly and painlessly increase by hypertrophy. The surfaces of the head, outside and within its various cavities, are frequently the seat of such lesions as would create the irritation required, but behind this, and giving it emphasis and force, we too often have a constitutional or general

¹ Porteau, Des lésions de la portion cervicale du grand sympathétique. Paris, 1869.

predisposition, or diathesis, which promotes and augments the pernicious effects. It is in the young and those of feeble constitution that glandular enlargements are most common, and it is not infrequent to find them present in various members of the same family. A temporary derangement of the health, due to unaccustomed strain on mind or body, may cause this malady to appear very quickly, and the best barrier which can be raised to its progress is to recognize and remove the depressing cause.

In constitutional syphilis, we frequently meet with small, hard, rolling, and painless glands in the back of the neck, and sometimes along the edge of the trapezius; but in neither position are they as constant or as characteristic as was at one time supposed.

In size, shape, consistence, and number of glands involved, there is much variety in adenitis of the neck. Its dimensions range from that of a pea, to that of a mass as big as the fist, and it may be round, oval, or irregular in shape, from the fusing or matting together of several glands. Its consistence varies from that of flesh to that of bone, and as regards number, while occasionally, but rarely, single glands are inflamed, they are more commonly met with in groups or chains, sometimes filling the whole side of the neck. If chronic, they are painless, and are slow to suppurate or break down, while long periods may pass with but little perceptible change in their size or connections. If from any cause more violent action arises in them, not only may the gland be destroyed, but the surrounding cellular tissue and overlying skin may partake in the inflammation, and, if pus works its way to the surface, sinuses may remain to mark the point of its passage. If the whole of the diseased tissue is expelled, these openings may close, and leave deep and indelible marks. If large and hard, and placed near compressible structures, these glandular enlargements may exert injurious pressure. Bloodvessels and nerves may thus suffer, as we see when the axilla is filled by glandular masses causing the violent pains and œdema in the arm which produce so much distress in carcinoma.

Caseous degeneration is a not uncommon affection of unhealthy youth, and is generally wide-spread in its ravages, attacking many glands contemporaneously or in succession. These glands are liable to suppurate, but not always in a distinct and satisfactory manner. Part of the gland may break down, while the stool or basis remains behind to feed the suppuration and delay the recovery. Early and efficient opening with antiseptic precautions, with, it may be, the free use of the spoon to remove the *débris* of the gland, is the most essential point in the local treatment. It is far from easy to avoid leaving disagreeable marks after such proceedings, but the surgeon's interference, if judicious and well directed, will produce less destruction, and leave less objectionable traces, than spontaneous evacuation of the pus.

When the glands of the neck become enlarged from malignant disease, they grow quickly, and produce early and disastrous pressure-effects, causing shooting pains along the nerves, interference with the blood supply, displacement of the soft structures, and implication of the skin leading to ulceration. The general health becomes involved, and thus from a combination of symptoms the true nature of the growth is recognized. It is secondarily to other cancerous deposits existing on the line of the lymphatic vessels converging to the glands in the mouth, throat, larynx, etc., that the disease appears. Primary cancer is extremely rare in these glands. When it occurs, many glands will be affected in succession, and soon such a condition will be established as to be beyond surgical aid. It is by the hardness and fixation of these masses, the pain in the nerves compressed, the early matting together of the growth and its close adhesion to the parts around it, the implication of the overlying skin and rapid deterioration of the health, that true cancer

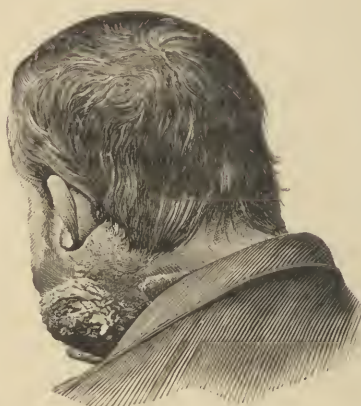
in these glands is distinguished from lympho-sarcoma and other tumors. The photograph here copied (Fig. 1101) was taken from a cast made from a case of malignant disease after death. It shows the terrible destruction which such

Fig. 1101.



Malignant tumor of neck.

Fig. 1102.



Malignant tumor of neck.

an affection may occasion before death relieves the sufferer. The other (Fig. 1102) was taken shortly before death from a patient under my care, in whom the nature of the affection was recognized when the growth was a small, hard, deep-set tumor, only four months before it attained the size represented.

LYMPHOMA has attracted much attention of late years. It is not uncommon in the neck, and is difficult or impossible to distinguish, in its early stages, from mere hypertrophy of glands. In minute structure this tumor resembles lymphatic-gland tissue, but its constituents vary considerably in different examples, the cells and the containing basis-fibre bearing different proportions to one another, and so causing the consistency of these tumors to differ.

When the cell-elements greatly predominate, the growth is not only less coherent and softer, but it becomes very malignant, infecting neighboring structures, and many and distant parts, contaminating the whole system, causing a general and characteristic anæmia, and killing miserably. This general form, this "lymphoid cancer" as it has been termed, is chiefly known in England as "Hodgkin's Disease,"¹ and abroad as lympho-sarcoma (Virchow) and lymphadenoma (Cornil and Ranvier).

The simple or local form may involve one gland or many, and may be confined to the neck. It may attain a great size, and occasion considerable pressure. It is firm, fleshy, movable, indolent, and loosely set in the part, and the skin over it is unchanged. This growth may begin on one side of the neck, most frequently at the angle of the jaw, or by the edge of the sterno-mastoid. It may progress very slowly, and may even remain stationary for a time.

¹ See Medico-Chir. Trans., vol. xvii. 1832.

Many masses may be adherent to one another, but they are readily shelled out when the overlying parts are divided.

In the general form of the affection, there will appear in other regions, as the armpit, groins, etc., similar growths to that present in the neck, while the spleen, liver, and other organs, may also present tumors of like structure. When the blood has become so altered in composition as to present a great excess of white corpuscles, then we have that "leucocythæmia" established which makes its presence so evident in the complexion. It is beyond our present art to differentiate the two forms of lymphoma where the growths are small and undeveloped, and even to distinguish them from chronic adenitis, can at times be but a happy guess. When the rapid growth, soft consistence, multiplicity, bossy contour, freedom from pain, and absence of all scrofulous taint, become apparent, then the idea of mere adenitis drops out of view, and, as the affection quickly progresses and shows itself in various parts, either internally or externally, and the general system begins to suffer, then the diagnosis of the special form of lymphoma present can no longer be doubted. In "white-blood" disease, an examination of the blood will of course demonstrate its condition. It is on the clinical history that our chief reliance must be placed, for though various instruments have been invented for securing a minute portion of the tumor for microscopic examination, such an examination could not furnish confidence in forming a judgment.

The photograph here copied (Fig. 1103) was taken from a cast in my possession, and is historically interesting, as it is one of those which were

Fig. 1103.



Lymphoma of the neck.
(From a cast by Allan Burns.)

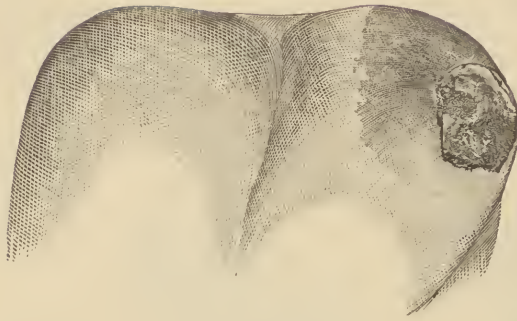
Fig. 1104.



Lymphoma of the neck. Dissection of the parts
seen in Fig. 1016.

made by Mr. Allan Burns, when studying the subject of the anatomy of the head and neck, for his well-known work; and the next (Fig. 1104) appears to have been taken from a dissection of the same. Fig. 1105 represents like

Fig. 1105.



Lymphoma of the neck.

them a case of lymphoma which was under my care, and in which the tumor occupied the clavicular region.

PAPILLARY GROWTHS are met with in the neck in both the simple and epithelial forms of warts, but they do not demand detailed notice.

NÆVI are not unusual in the neck, and may be either arterial, venous, or mixed, cutaneous or subcutaneous, etc., as in other parts, but there is nothing in their nature, progress, or man-

agement, special or peculiar, derived from the region in which they occur. I have twice had occasion to excise deep arterial nævi lying on and implicating the sterno-mastoid muscle. In the first case, the growth, before being cut upon, had all the physical characters of a glandular tumor, and, as it was enlarging and causing deformity, the patient (a female) wished it removed. There was no pulsation observed till the soft parts were divided, and it was prominent and firm. It bled very freely indeed when touched with the knife, and it had to have needles placed under it, and a twisted suture applied, before the bleeding could be arrested. When the true nature of the tumor was recognized, it was removed along with an inch and a quarter of the muscle which was involved. This patient died of septicæmia in ten days. In the second case the tumor had been cut into in the country, and the patient was sent to me in Glasgow, with many pins and ligatures in position, which had been applied to command the serious bleeding that had taken place. In this case the tumor was successfully excised along with all the affected muscle. In both cases the nævoid nature of the tumor was recognized after removal.

It is always to be remembered that venous and mixed nævi usually disappear spontaneously after teething is over, and that injections should never be used in dealing with these affections on the head or neck, from the danger, which is very real and imminent, of causing thrombosis. Excision is by far the best mode of dealing with nævi here and elsewhere, when it can be employed, but the ligature, cauterization, electrolysis, etc., may in some cases be preferred.

LIPOMA is sometimes met with in the neck, and may attain a very great size, growing slowly and painlessly, and only occasioning harm by its mechanical effects. Such a growth may affect even a young child, and may appear for the first time soon after birth. No part of the neck is exempt from these tumors, but it is on the posterior aspect that they have been most usually seen. Liston refers to several examples of large fatty growth in the neck, and medical literature is rich in such cases; in many instances very large tumors of this kind have been successfully removed.¹ Their physical characters are all well known. They may be sessile or pedunculated, doughy to the hand, and occasionally so soft as to appear fluctuating. They may be in rare cases symmetrical, and they may, it is said, occasionally cause the skin to ulcerate

¹ See Trans. Pathol. Soc. of London (especially for 1860); also Indian Med. Gaz. 1874.

over them. They are movable, grow slowly, are painless, and have the superficial veins sometimes enlarged and prominent. Long prolongations may pass deeply from these tumors among the muscles, and even around the bloodvessels, giving but slight indication of their existence as the movability of the growth is thereby little affected; but, as a general rule, lipomata do not dip beyond the subcutaneous cellular tissue. When the skin over them is rendered tense, the line of attachment of the interlobular partitions will be seen, and this is distinctive. The hardening effects of ether, which has been used to differentiate fatty growths from others, is quite unreliable as a diagnostic test.

Fig. 1106.



Large lipoma of neck.

FIBROMA, ENCHONDROMA, AND OSTEOOMA are unusual tumors in the neck, but in connection with the ligamentum nuchæ, or the vertebral periosteum, we may have the two former, while enchondroma may also be met with in the parotid and submaxillary glands, and exostoses occasionally grow from the transverse processes of the vertebræ. Fibrous and cartilaginous tumors, as a rule, grow slowly, are smooth or lobed, and in consistence vary from being elastic to being stony hard. They may attain a great size, are often quite movable and free from pain, and are covered by unchanged skin; they may too, as may more especially the exostoses, give rise to much suffering by their pressure on nerves, and may interfere greatly with the circulation in both arteries and veins.¹

NEUROMATA, both single and multiple, have been recognized in connection with the fifth, sixth, and seventh cervical nerves. They have been observed most usually on the pneumogastric, but the sympathetic and phrenic also have both been found so affected.²

SYPHILITIC GUMMATA may appear in the glands and subcutaneous tissue of the neck, and also in the sterno-mastoid muscle. They may soften, suppurate, and discharge, leaving fistulæ. The sterno-mastoid is also occasionally the seat of chronic inflammation of a syphilitic nature, and of a curious hardening which goes by the name of "myo-sclerosis." When affected with chronic inflammation (in the secondary or tertiary stage of the disease), there are tenderness, stiffness, and irregular swelling in the muscle, and the pain is increased by motion of the part.³ The external and internal use of iodine is the best remedy for this condition.

¹ Trélat, *Gazette des Hôpitaux*. 1868.

² Accounts will be found of such growths in the well-known monograph of Professor R. W. Smith, of Dublin; in *Langenbeck's Archiv*, Bd. iii.; in *Mém. de la Soc. de Chir.*, tome iii.; in *Pathol. Trans.*, vol. viii.; and in *Comptes Rendus de l'Acad. des Sciences*, 1845.

³ Bouisson, *Gaz. Méd. de Paris*. Juillet, 1856.

MYO-SCLEROSIS. (*Congenital Induration or Tumor of the Sterno-Mastoid.*)—As to *myo-sclerosis*, it appears a few days, or at most weeks, after birth, and appears to be due to inflammatory exudation. Part only of the muscle may be involved, or the whole of its extent may become hard like bone, and swelled so as to present a very noticeable condition. It is always unilateral, and has its seat in the sheath of the muscle. The skin is not involved, and pain may be occasioned when the muscle is compressed or put in action. In the last case which fell under my observation, all movement of the head appeared to produce much uneasiness. No explanation quite adequate to account for this curious affection has yet been found. Strains during delivery, or the pressure of the forceps, may in some instances account for it; but it has also been observed in cases in which the child has been born without any difficulty whatever. No hereditary or constitutional state has been so commonly associated with this affection as to establish the existence of any connection with it. The spontaneous disappearance of this condition after some months—from two to six on an average—and the restoration of the muscle to its normal state, may be expected with confidence; if any interference were thought of, it would probably take the form of friction, or possibly gentle counter-irritation—but these measures are really unnecessary.

LYMPH-ANGEIOMA is a name given to a rare tumor formed of capillary lymphatic vessels, which has been said to occur in the neck and to attain a considerable size. Nothing is known of its etiology or clinical characters that is reliable or worthy of remark.

Solid growths of the neck, especially glandular tumors, occasionally derive a more or less distinct pulsation from contact with, or adhesion to, the carotid artery. If the tumor surround the artery, as it has been found to do, then the deception is complete, as the pulsation appears excentric and expansive. It will be chiefly by careful inquiry into the clinical history of the case, by noting its progress, the consistency and outline of the tumor, the possibility or not of pushing it aside and so arresting the pulsation, and at the same time of defining the outline of the growth and the position of the artery below, and finally by observing the probable existence of other similar tumors when the disease is glandular, that the diagnosis is arrived at.

As to the treatment of these various tumors, it will be best given in the order in which they have been spoken of.

Treatment of Cervical Tumors.—*Chronic adenitis* will demand, in the first place, the correction of the cause, constitutional or local, on which it depends, if that can be found, and is capable of being dealt with. In many cases the digestion is deranged and the system lowered. The assimilating organs will require careful attention, and their vigor must be maintained or improved; then iron, iodine, phosphorus, and cod-liver oil may be given in some of the many combinations which have of late years so much simplified the administration and increased the usefulness of these remedies. The hygienic surroundings of the patient—his dress and exercise, his food and air supply, the action of his skin, etc.—will profitably engage the surgeon's attention and supervision. Sea-air has a well-established reputation in these cases, especially when the scrofulous diathesis is present. If there is any suspicion of syphilis, that will supply an important hint to guide the treatment. If inflammation should arise in the glands, fomentations, and it may be one or two leeches applied close to the affected part, will be serviceable, but cold is not to be commended. Counter-irritation by colorless iodine, or by a lotion containing iodine with iodide of potassium and a little spirit, or by the various ointments

into whose composition iodine enters, is, if properly regulated, most useful in the subacute and chronic stages of simple adenitis, but it is very liable to abuse and overuse, and must be supervised. The employment of more powerful local applications, such as cantharides, tartar emetic, croton oil, or mercury, is hazardous, because of the risk of inducing too violent action. Belladonna, too, to relieve pain, is rarely required, and in young persons may occasion annoying symptoms. If suppuration occur, the pus cannot be too early evacuated, and this should be done by a clean cut with antiseptic precautions. That is better than the use of the aspirator, seton, etc., which rarely fulfil the end in view, and may irritate and do harm. Such puerilities as applying the iodine, not to the gland, but to the part (mouth, nose, etc.) from which its lymphatic vessels are derived, need hardly be mentioned.

Shampooing, compression, crushing, acupuncture, and galvanism, either in the form of galvano-puncture or of the continuous current, have all their advocates in dealing with hypertrophy of cervical glands. Shampooing is very liable to be overdone, and so set up inflammation. Pressure cannot well be applied in the neck, except, perhaps, in the parotid and mastoid regions, where there is bone behind; but special forms of apparatus have been invented for its employment. Compresses of metal, wood, bone, agaric, charpie, etc., have been applied, and expensive and elaborate instruments have been constructed, but their success has been small, and occasionally the harm caused has been considerable. Crushing alone, or combined with subcutaneous division by a cataract-needle, has too often been attended with diffuse inflammation and suppuration. Mere manipulation has been used as a step preparatory to excision, "in order to render the gland more movable." "Igni-puncture," or the introduction of a pointed, red-hot iron into the middle of the mass, or the placing there some of Maisonneuve's chloride-of-zinc pencils ("flèches"), have both been fairly tried, but with very indifferent success. Such applications are very painful, very violent, and attended with marked danger in deep and large tumors, and they leave serious scars.

Electrolysis is slow, troublesome, and generally unsatisfactory, but there are cases on record in which considerable masses of scrofulous glands have been dissipated by perseverance in its use.¹ Interstitial injections of many kinds have been tried. Various solutions of iodine, nitrate of silver, chloride of zinc, salts of sodium, alcohol, perchloride of iron, and carbolic acid, and Fowler's solution of arsenic, have been employed. In most cases the aim has been to set up suppuration, and so to break down the mass; but iodine, when so introduced, in the simple, chronic form of adenitis in healthy persons, is undoubtedly a valuable remedy. It causes absorption, with but little disturbance, if used in small and repeated quantities, passed by means of a small hypodermic syringe deeply into the tumor, after the surface has been rendered insensible by the ether-spray. In scrofulous subjects, it is apt to be followed by suppuration and local disaster. Injections of solutions of chloride of zinc have, however, even in scrofulous cases, occasionally answered well. The excision of hypertrophied glands has been often practised. In simple chronic adenitis, and in scrofulous enlargements, it is quite justifiable when other measures of less violence have failed, unless in children and young persons, for whom time and improved hygienic conditions may be expected to do much. It is, perhaps, in healthy females—in whom local and general remedies have failed, and who suffer from superficial, distinct, chronic, and movable growths, which occasion deformity and annoying pressure—that excision is most justifiable. The position, size, connections, etc., of the tumor, must guide the

¹ Golding-Bird, *Lancet*, 1877.

surgeon in determining his conduct, together with the clear conviction that less severe measures have been exhausted, and that the case is such as to demand such a step being carried out. No doubt the use of antiseptics has greatly diminished the risk of such operations, and the mark left may, by a careful planning of the line to be followed, together with the rapid union which antiseptic surgery insures, be very insignificant. The propriety of getting rid of serofulous collections is now well understood, and contrasts with the old fear of such interference causing outbreaks elsewhere.

The treatment of *carcinoma* in the neck is, as might be expected, most unsatisfactory. Generally it is quite beyond the surgeon's aid. It cannot, as a rule, be completely excised from the connections which it has formed by the time its true nature is recognized, and as the tumors are usually secondary to other, like growths elsewhere—which are often still more inaccessible—it would be of little use to remove them. Interstitial injections are highly dangerous in such growths, and chloride-of-zinc arrows are of very limited application in this region of the body.

Lymphoma.—The treatment of this disease in any form is confessedly very difficult and unsatisfactory. All irritating applications tend to make these tumors increase with enhanced speed, and electricity has proved quite useless. When the growths are part of a general affection (*lympho-sarcoma*), no remedy is of any value, and interference is to be declined, though arsenic and phosphorus, when injected into the tumor or given internally, so as to develop their poisonous effects, have been said, on reliable authority, occasionally to arrest the progress of the disease. These favorable results, however, have too rarely been secured to make the risk of their employment quite justifiable. Arsenic in particular, when used by interstitial injection, occasions most violent effects, difficult, or impossible, to regulate or command; and there seems good reason to suppose that any influence which the drugs named have in retarding the growth of the tumor, is only due to the general depression which they bring about in the nutrient functions—an effect equally seen after attacks of acute rheumatism and erysipelas. From the loose connection of lymphoma, it is easy to shell it out before it has attained a great size; but if the constitution be involved, a rapid recurrence will take place. If the larynx or trachea be seriously compressed, it may be necessary to open the windpipe.

An observation of Duplay is worthy of record, though its clinical use has not been found great. It is this, that if a tumor of the nature now under consideration increases in the direction of the lymphatic vessels, that is, downwards towards the chest, the worst opinion may be formed of its nature; but if, on the contrary, it grows in the contrary direction, that is, against the flow of the lymph, a more favorable prognosis may be formed.

When similar growths occur in other regions of the body, all interference is of course plainly unjustifiable.

Fatty, fibrous, and cartilaginous tumors can only be excised, if they are interfered with at all. If they are increasing, the sooner such a step is taken the better. A deep dissection will, in all likelihood, be required to effect the removal of fibroma and enchondroma, and no small difficulty may attend the separation of their deep connections. So great has been the intricacy of their relations in not a few recorded cases, that it has been found necessary to remove them piece by piece. The risk of wounding the veins is especially great.

The treatment of *venous or mixed nævi* of the neck differs in no way from their management elsewhere, except that coagulant injections are here very dangerous, from the risk of clots being carried into the blood stream. Arterial nævi are best excised or strangulated by passing needles under them and

applying the twisted suture. Electrolysis, cauterization, and the ligature have all been applied to nævi of the neck.

Syphilitic tumors are to be dealt with through the general system, according to the stage of the disease in which they arise. Iodide of potassium and iron in large doses are, as a rule, the most efficacious treatment, with possibly the careful administration of the green iodide of mercury in the event of the other remedies failing, or being slow to act. Iodine may also be applied locally.¹

CYSTS OF THE NECK.

There are many forms of cystoma met with in this region. Some of these tumors lie above and some below the cervical aponeurosis. Some are solitary, and others are found in groups forming large and formidable tumors.²

CONGENITAL SEROUS CYSTS (*hydrocele of the neck; hygroma*) have their seat in the subcutaneous cellular tissue, and are chiefly seen on the left side of the neck in its antero-lateral region. They are usually unilocular, but are at times divided into various compartments by imperfect partitions. They are, for the most part, round, smooth, elastic swellings, having but a loose connection to the parts above and below them. If very tense, they may communicate to the hand the firmness of a solid growth. It is seldom that they are sufficiently prominent to enable translucency to be made out, but a certain bluish or opaline color can be sometimes distinguished. They cause no pain, but as they may attain an enormous size, so as even to fill the whole side of the neck, their bulk and the deformity which they occasion may cause much inconvenience. The contents may vary much in color and consistence, being at times like water, and at other times thick, and of a yellow, green, or dark-brown color, from mixture with blood. More rarely there are solid contents. The fluid is saline and albuminous, and if there are several cysts combined, each may have a different colored fluid within it. The cyst wall is usually very thin and delicate, so as to be difficult to recognize and remove; but in consequence of inflammatory deposition it may become thick and resistant. These cysts are not vascular, and the skin covering them may be healthy and unchanged. They do not, as a rule, cause functional disturbance; but in young children, when they attain a large size and are deeply placed, they may occasion a dangerous amount of pressure. If injured and consequently inflamed, or if bleeding take place into them, a serous cyst may become a source of danger. The least dangerous position for serous cysts (though they may cause much deformity when placed there) is the back of the neck, where they may reach a large size. When a number of cysts are combined in a congeries, the grouping may vary considerably, as secondary growths may be attached to the main mass and give it a very irregular shape. Congenital cysts occasionally undergo spontaneous cure. They may burst inwards into the pharynx, or outwards by the skin. They may become consolidated after inflammation, and may then disappear by absorption.

CYSTS CONTAINING TEETH, HAIR, CARTILAGE, ETC., have in rare instances been seen as congenital growths in the neck. They are soft, round, smooth and

¹ Bouisson, Gaz. Méd. de Paris. Juillet, 1856.

² On this subject see Voillenier, Des kystes du cou. Paris, 1851; Boucher, Étude sur les kystes congénitaux du cou. Paris, 1868; Maunoir, Mémoire. Paris, 1825; Hawkins, Med.-Chir. Trans. 1839; Bryant, Med. Times and Gazette. April. 1876; Anger, Bull. de la Soc. de Chirurgie. Déc. 1875; Vernher, Die angeborenen Kystenhygrom; also many papers in Langenbeck's Arch. für klin. Chir., in the English Med. Journals, in the Gazette des Hôpitaux, Arch. Gén. de Médecine, etc.

indolent, and often deeply placed and firmly connected. If they are opened or burst, they give rise to very troublesome fistulous openings.

COMPOUND CONGENITAL CYSTS.—The compound congenital cyst, from the deep position which it may occupy among the muscles (going even behind the pharynx and œsophagus), and from its close relation to important structures, is often a very formidable affair. It may be made up of many separate masses, or the growth may appear to be lobed, from being bound across by muscular or cellular bands, or by the partial or complete division of the cyst by partitions within. These cysts occur on the back of the neck, and not unfrequently in front, to the inner side of the sterno-mastoid. These growths have been seen at birth of a size to impede delivery. They have not only covered the whole side of the neck, but have hung down in front of the chest, and by their pressure on the floor of the mouth have occasioned serious difficulty in both breathing and swallowing. Various vices of conformation may be found to accompany them—conditions not connected with simple congenital cysts. Their contents are very much varied (glandular, sarcomatous, cartilaginous, colloid, and sanguineous elements), and their walls are not unusually hard and thick from calcareous, cartilaginous, or bony deposit, or from having undergone sarcomatous or other change. From the nature of their contents and the alterations in their walls, these cysts are firmer and more irregular in outline than simple cysts. Their consistence may vary greatly in different parts of their surface, being soft and fluctuating at one part, and hard as bone at others. There is little or no pain, and no pulsation, but the veins on their surface may be enlarged. They may burst and disappear, but at other times this occurrence has led to the breaking up of the patient's health.

NON-CONGENITAL CYSTS are sufficiently common.

The *sebaceous cyst* occurs here as elsewhere, and presents its usual, well-known characters. When deeply placed, as it occasionally is, it is difficult to be certain of its true nature before puncturing it.

The *sanguineous cyst* occurs mostly in young children, and appears to be due to bleeding into a serous cyst. The blood may be at rest within the cavity, or there may be a direct connection with a vein which allows of its circulation through the interior of the cyst.

Hydatid cysts are very rare, and their real nature may not be known till they are punctured. They may lie superficially, or they may be placed deeply among the muscles, especially on the back of the neck.

Symptoms of Non-congenital Cysts of the Neck.—Non-congenital cysts in adults grow slowly as a rule, and remain long stationary, and often attract little attention till they have attained a considerable size. If they are affected by inflammation, their rate of progress may be greatly accelerated, and they may become what otherwise they are not, painful. These cysts, however, occasionally make a rapid start in growth without any apparent cause. If small, they may appear to be solid from their tenseness, but if large, their soft consistence is commonly evident. No help is got in their examination from transparency. The skin covering them is not involved, and they are as a rule movable, smooth, and without pulsation or *bruit*, unless it be merely a heaving when they are in contact with the carotid. It is said that Mr. Syme on one occasion ligatured the common carotid for a supposed aneurism, when in reality it was a thick-walled cyst adherent to the vessel's side. The kind of movement, and the effects on the tumor of arresting the current of blood by pressure applied at the root of the neck, will, with the history, best aid the surgeon to avoid a like error.

The non-congenital cysts of the neck occur most frequently in connection

with the glands of that region, though they may grow in the cellular tissue without any relation to the glandular structures. When situated in front of the neck, such a cyst may be confounded with goitre, which it may closely resemble in physical characters; but if a clear clinical history is obtainable, the distinction can be made, seeing that the goitre springs from a different part of the neck, and that it is only in their later stages that they come to coincide in position, and that, as a rule, the goitre is firmer, and has a movement with deglutition, and often, also, an effect on respiration, which is not observed in the case of a cyst unconnected with the thyroid body.

Diagnosis.—From spina-bifida and encephalocele, a cyst of the neck is differentiated (in those cases in which its position might cause the question to arise) by being more superficial, by having no connection with or influence upon the spinal cord or the brain, even when compressed, by exhibiting no movement on expiration and no pulsation, by not being reducible or pedunculated, and by there being no aperture in the parts below, such as may be frequently detected in hernia of the membranes of the cord or brain.

In many instances it is impossible to distinguish a cyst composed of a single cell, from one having many compartments. If the wave of fluid caused by percussion is found to be circumscribed, and if various distinct centres of movement are made out in a tumor, then its multilocular character cannot be doubted; but it is by no means the case that this is usually recognized in a satisfactory manner, and that because of the varying thickness of the cyst-walls and contents. In small cysts, even fluctuation may, from such causes, be very obscure and difficult to define. An exploratory puncture may be necessary to discover what is contained in such a cyst, but a consideration of the age of the patient, and the shape and history of the tumor, will supply important aids to diagnosis.

As to *prognosis*, it will, of course, turn on the nature, position, size, and connections of the cyst, and on the age of the patient. When large and deeply placed, in young children, the cysts will manifestly prove very dangerous. The multilocular cysts are worse than the unilocular, as they attain a greater size and are more difficult to deal with.

The *etiology* of cysts of the neck is very obscure, and as yet little understood. They have been ascribed to many causes, some of them not a little fanciful—injury received during pregnancy, undue uterine contractions, pressure from the umbilical cord, etc. That sanguineous cysts may arise from contusions or strains during delivery, has more probability to commend it. The various cysts have been traced by different observers to the bloodvessels, glands, and cellular tissue, and have been ascribed to imperfect development of structure, and to the uncertain realm of “new formations;” but notwithstanding the ample discussion which this point has undergone, little reliable light has yet been thrown upon it, and consequently it would be fruitless to dwell upon it further.¹

No hereditary history can, as a rule, be traced regarding the occurrence of these cysts, and nothing important or reliable is known with reference to the influence of sex, age, etc., in their production.

Treatment.—In very young children it is well to delay, if possible, all interference till the strength of body diminishes the danger. Repeated punctures, aided, if possible, by compression, may retard the progress of these cysts.

The plans which may be pursued in the treatment of cysts of the neck are numerous and diversified, in order to meet the requirements of the various

¹ Reference can be made to Lücke, *Traité des Tumeurs*; Pitha und Billroth's *Handbuch der Chirurgie*; Richard, *Bulletin de la Soc. de Chir.* 1851; Lawrence, *Medical Times*. 1850; Voillemier, *Des kystes du cou*. 1851; *Comptes Rendus de la Société de Biologie*. 1853, 1854; Giraldès, *Bull. de la Soc. de Chir.* 1859; Verneuil, *Tumeur congénitale du cou*. 1875.

conditions and forms of the affection. If the contents could be got rid of by absorption, it is manifest that much would be gained. If this cannot be accomplished, then the evacuation of the fluid, followed by the obliteration of the sac, would present itself as the least objectionable device, while its destruction by caustic, its incision, or its entire removal by excision, might be in certain conditions the most feasible or most promising mode of management.

Compression is difficult or impossible to apply in the neck, so as to be effective and enduring. Even elastic collodion, which seems well adapted to exercise a certain useful pressure, proves objectionable in young and tender children from the irritation which it causes. Counter-irritation by iodine or cantharides, and the use of mercury or muriate of ammonium in solution or ointment, cause too much irritation in the child, and so are productive of harm. It is seldom that any appreciable or abiding influence is thus exercised in inducing absorption. To puncture the cyst without attempting to obliterate the sac, can only be a temporary expedient, as the fluid is quickly re-formed. In sanguineous cysts, serious and even fatal bleeding has in a few cases followed simple puncture. A fine aspirator needle is the best instrument to employ, if puncture is to be tried. To excite adhesive inflammation in the sac, after it has been emptied, has been attempted by the use of electricity, injections, the seton, etc. From the first of these agents little good has been got, though it has been frequently tried, and in many ways. Of the various injections, iodine has commended itself most. If thrown into a bloodvessel, or employed in too concentrated a form, it will unquestionably be followed by mischief; but these errors are not likely to occur when their possibility is present to the surgeon's mind. The quantity used is generally equal to half the bulk of the fluid which has been in the first instance withdrawn. It is thrown in slowly, through a small canula, which has been carried a short way under the skin before entering the cyst, so as to diminish the risk of air being introduced. A previous puncture of the skin with a knife, allows the canula to be passed with less force and with more precision. No washing-out of the cyst, preparatory to the injection of the iodine, is requisite, but that fluid should be allowed to escape (without squeezing) after it has remained in the sac for a short time. This, at least, is a safe precaution to enforce on the first occasion, as we cannot be certain what degree of action will be set up, and it is not wished that it should be too great. It is also well to wait the full effects of each injection, before another is used, and to be guided thereby. If pressure could be afterwards applied, it would materially aid the injection. Heated wine, alcohol, perchloride of iron, chloride of zinc, etc., have also been used by injection, and occasionally most disastrous results have followed from excessive inflammation. Some practitioners desire to occasion so considerable an amount of inflammation as to produce suppuration, but it is difficult to restrain or guide such a complication. A seton is obnoxious from the undue irritation which it is apt to cause, and, in its usual form, from its obstructing rather than aiding drainage; but a small vulcanite tube, or carbolized catgut (which is capable of being absorbed), or horse-hair, might, when injection failed, be thought of. The interior of the sac may be washed out, through a drainage-tube, with Condyl's fluid, or with one of the unirritating antiseptic agents now in use. It is difficult to apply injections to the interior of multilocular growths. Jules Roux's suggestion, first to break down the partitions between the cysts, is more specious than practical.

To destroy a cyst of the neck by the application to its external surface of caustic in any form, can hardly be advocated, as such a method is not only slow, violent, painful, and uncertain, but leaves a most objectionable scar behind. A mark must also result from incision, but it need not be great, and if antiseptic precautions are taken there will not be that risk of inflammation and suppu-

ration in the cyst which constituted the chief objection in former times to this procedure. The drainage must, however, be carefully attended to, as otherwise annoyance or danger will arise. Laying the sac open and applying caustic to the lining, so as to cause its destruction, is a practice now seldom followed.

Excision has its chief use in dermoid cysts, and in multilocular cysts which threaten asphyxia, when no less serious or difficult plan of treating them is available. Experience does not, however, encourage these operations, and they have proved, in the case of large cysts, very difficult and sometimes very disastrous. The deep relations of these growths are frequently such that extirpation is impossible.

The ligature is not adapted for the removal of cysts of the neck, though in cases of attempted excision, the deeper portions may sometimes be thus dealt with.

SURGICAL AFFECTIONS OF THE THYROID GLAND.

This very vascular gland, lying on either side of the upper part of the trachea, in near proximity to the great bloodvessels, is a ductless, encapsuled body, largely supplied with lymphatics, and consisting of a cellular structure of firm texture, pervaded by a glairy, gummy, yellowish fluid, which coagulates when heated. The two lateral portions of the thyroid, which lie on either side of the windpipe, are connected by a bridge or isthmus which covers the three upper rings of the trachea, where also an intermediate lobe or pyramid may exist.¹

The thyroid varies considerably in size in different persons, and may atrophy and almost disappear in the old. It is liable to temporary enlargement during menstruation and pregnancy, afterwards resuming its normal size, or nearly so, and no change of structure being caused by such increase. Permanent enlargement occasions that condition which is called "bronchocele," or "goitre," or, in England, "Derbyshire neck." There is great variety in the degree of this abiding enlargement. It may cause only a certain broadening of the neck, which attracts little observation, or it may produce a great pendulous mass covering the whole front of the neck, and in extreme cases extending down in front of the abdomen.²

HYPERTROPHY OF THE THYROID, OR GOITRE, may be simple and without much structural change. It appears to be more common on the right side than on the left, and may be confined to one side and the isthmus, or at least these parts may be developed out of all proportion to the rest of the gland. Goitres have been variously classified according to their structure. The terms solid and liquid goitres, cystic and parenchymatous, etc., have been proposed as distinguishing the leading forms. The cysts of which these growths may be chiefly composed, vary widely in size, shape, contents, etc. The contents may be a clear and albuminous fluid, or a gummy, gluey, or jelly like material, or may consist of blood, or may be made up even of calcareous matter. The interior of the cyst may also present much diversity as to shape and construction. The cavity may be divided by septa more or less complete. The walls, sometimes thin and pliant, are at other times hard and rigid, with calcareous and osseous deposits. These walls are firmly attached to the gland, but only

¹ See Boéchat, *Recherches sur la Structure du Corps Thyroïde*. Paris, 1873; and Burns, *op. cit.*

² See Berger, *Archives Générales de Médecine*, 1874; also Virchow, *Krankhaften Geschwülste*.

loosely connected with the surrounding structures. When the walls are thus hard and dense, the disease has been termed "cartilaginous" or "osseous" goitre. A considerable amount of the growth may consist of dilated bloodvessels, and if these burst so as to allow of bleeding into the substance of the tumor (into the cyst, or into the parenchyma), a species of apoplexy is produced. If it be the arteries which are chiefly enlarged and convoluted, the goitre has been designated "aneurismal," while if it be the veins which are mainly involved, it is termed "varicose" goitre. Both sets of vessels, however, but in varying degrees, are commonly affected.¹ Expansile pulsation, vibratory thrill, and "bruit de souffle" have been occasionally observed in aneurismal bronchocele.

The worst forms of goitre are met with in the narrow valleys running into the great mountain ranges of Asia, Europe, and America. In many of these localities it is endemic. It is met with in France, Savoy, and Switzerland; in the chalky parts of England and Central Scotland; in the valleys of the Himalayas, and in Thibet and Oude; in the Atlas range of North Africa; in the Cordilleras of South America, and in Chili and Peru; in Mexico and in Virginia, and in other mountainous regions of North America. I have repeatedly seen it in patients from the high-lying districts in the centre of Scotland, where it is little known to exist. A condition similar to that seen in man is occasionally found in dogs, horses, cows, and cats.

Etiology of Goitre.—The hereditary character of goitre has not been clearly established, though it is often asserted. When both parents suffer from the disease, the children are usually similarly affected, and are not unfrequently cretins and idiots. Whether, however, this result is not more correctly to be ascribed to the identity of exciting causes acting on both children and parents, rather than to any inborn influence, is at least a fair contention. The true cause of goitre has probably yet to be found. It has been diligently sought after and abundantly discussed. Coarse food; impure water, from mixture with snow or calcareous matter (sulphate or carbonate of lime); vitiated air; want of sunlight; a constant residence in low-lying and damp, or in elevated, cold, and exposed habitations; a "peculiar state" of the atmosphere; physical conformation of the country; extremes of temperature; intermarriage within a narrow circle; repeated congestions of the neck from violent efforts which force the blood into the vessels of the head and oppose its return—have all been described as its cause; but none of these are constant concomitants, and at best are only entitled to be considered as predisposing causes.

Symptoms.—Goitre is usually chronic in its progress, and may long remain stationary. Perhaps the most remarkable instances of acute bronchocele are those recorded in 1861 by Collin,² as having occurred at Briançon the year before.

Women, especially those of a sanguineo-lymphatic constitution, are most subject to it. It seldom becomes developed till after a child has reached ten years of age, though it has been seen in rare cases to appear shortly after birth.

A goitrous tumor rises and falls in deglutition, and is, as a rule, painless, and covered by unchanged skin, whose veins are unusually evident. It may be smooth or lobed, and of various shapes. It may exert severe and even dangerous pressure on the windpipe ("*goître suffocant*"), and may cause alteration or loss of voice, and dysphagia. It has been seen to surround the trachea, and penetrate between it and the œsophagus, so as to compress both passages. The trachea may be thus flattened or pushed to one side. The great vessels

¹ See Heidenreich, *Der Kropf*. 1845.

² *Recueil de Mémoires de Méd. de Chir. et de Phar. Militaires*. 1861.

and nerves, too, may be constricted by its wedging itself behind the sternum, and this has followed from goitres of even small dimensions when so placed.

Diagnosis.—Goitre is distinguished from glandular tumors by its point of origin, and by its consisting of one or two slowly-growing masses, and not of multiple swellings, at first distinct and finally coalescing, and occurring in different positions from that of the thyroid bodies. Hydroceles of the neck, abscesses, and hydatids, have all a different clinical history, and, for the most part, a different position, and their physical characters and progress are different. An aneurism of the carotid is altogether distinct in position, character, and effects. Tubercular disease is rare in the thyroid, is indolent in its progress, occurs in persons of a special diathesis, and is commonly combined with similar disease elsewhere. Disseminated abscesses and fistulous openings, too, are usual in tubercular affections.

Scirrhus is known by its hardness, mode of growth, fixation, bossy and irregular outline, absence of fluctuation and pulsation, great pain and rapidly-established pressure-effects, and by its influence on the general health.

Treatment.—Internal remedies are of little use when bronchocele has attained a great size. When recent, and of small or moderate dimensions, such remedies may prove serviceable in the measure with which they improve the general health and vigor, and correct those conditions on which the disease may depend. The removal of the patient from the district in which the disease has been contracted to a healthier one, careful attention to the sanitary surroundings of his dwelling, and also to his food and water supply, are measures which at once suggest themselves. If any of those supposed causes which have been already alluded to be in action, they must be removed or counteracted.

Iodine, given internally, has long enjoyed a large measure of confidence in the treatment of bronchocele. Sponge, first used by the Arabians, was administered as an electuary, or in the form of pastilles, tablets, etc. It was also burned and applied externally, as well as given internally. Coindet, of Geneva (whose name is intimately connected with this subject), used the hydriodate [iodide] of potassium, which is, perhaps, still the best preparation of iodine to use in this affection. It should be given freely, and is well combined with quinine and iron. "Lugol's solution" (that is, iodine, 20 grains; iodide of potassium, 30 grains; water, 1 ounce; dose, six to twenty minims) is also a very favorite prescription with many. Iodine, however, is used in a great variety of ways in the treatment of goitre, and in doses of all degrees of concentration. It has been exhibited in natural and artificial mineral waters, in food, in wine and milk, and even in cigars and snuff, but few now-a-days have the same faith in it as formerly, or believe it to possess any "specific" action in bronchocele. When combined with iron and accompanied by other measures tending to improve the general health, it is no doubt very useful.

Every kind of local treatment of goitre has had its advocates. Leeches, purging, counter-irritation, and electricity have all been tried and found of no avail, unless to relieve congestion or the slighter forms of hypertrophy. Iodine is the most commonly employed external application. In the form of tincture, or as an ointment variously combined with camphor, lead, mercury, etc., it has long been used in both the cystic and solid forms of goitre. In the East Indies, the biniodide of mercury (5ij to the pound of lard) has a high repute. According to Mouat¹ it is best rubbed in, in the early morning, for about ten minutes, a fresh portion being then applied, and left to be absorbed, while the tumor is exposed to the heat of the sun. When the skin

¹ Indian Annals of Medical Sciences, 1857.

becomes irritated, the application should be desisted from till the part is again free from pain. I have, in Scotland, occasionally seen much good result from this treatment, fire-heat being substituted for the sun's rays. The action of the remedy is apt to be too violent unless watched. The compound iodine ointment of the British Pharmacopœia, the iodide of ammonium ("colorless iodine"), equal parts of camphorated mercurial ointment and iodine, are other forms of the application which are sometimes used.

Cysts may be simply tapped, or may be injected as well as emptied. Mere tapping can only afford, as a rule, temporary relief, and, however carefully managed, has not always proved free from danger.¹ Rarely has it led to a cure, as it did in a case related by Gosselin. Consecutive hemorrhage and profuse suppuration have occasionally followed mere tapping. Iodine is the favorite substance chosen for injection, but alcohol, ergot, and perchloride of iron are also used. The tincture of iodine, mixed with water in the proportion of one to four, or stronger, or combined with camphor or alcohol, has been frequently employed. Dr. Morell Mackenzie² prefers a drachm of the tincture of the perchloride of iron in half an ounce of water, injected after drawing off the fluid by a dependent, central puncture, with a trocar and canula. The canula is left in place and plugged after the injection is made, so that the iron solution may be re-introduced at intervals of a few days, till suppuration is set up, after which the tube is withdrawn and poultices are applied, and the affection treated as a chronic abscess. Iodine, iodide of potassium, camphorated spirit of wine and rose-water, are recommended by Bouchacourt.³ Maunoir used wine, but it is wholly inefficient.

In old, hard goitres, interstitial injections are powerless. Nothing short of removal is of much service in such cases. It is in the cystic and glandular forms that injections of iodine are of most value; and though it is not unusual for the immediate effects to be violent, and even alarming, yet in a few days the beneficial results will show themselves. The surgeon must proceed with caution, and be guided as to the strength of the injection and its repetition, by the effects of the last operation. In vascular goitres, solutions of the perchloride of iron are to be preferred.

Incision followed by plugging has also been employed in the treatment of cysts of the thyroid. Portions of the cyst may at the same time be removed. Violent and irrepressible bleeding has, however, thus been occasioned, and has ended most disastrously. Billroth's experience of this method has been very unfavorable. Caustics and the actual cautery have also been used to open the cavity of the cyst, so as to diminish the risk of bleeding; and pieces of caustic have been suspended within the cyst, in the delusive hope of diminishing the dangers of using the knife.

The wire or thread seton is also another method of treatment which has been practised; but here, too, violent bleeding and inflammation have arisen, and have ended fatally.

Pressure has been well spoken of by an American surgeon, Dr. Dwight.⁴ He applied it by means of adhesive plaster.

In the vascular form of goitre it has been proposed to tie the main vessels leading to the tumor. This operation is difficult and dangerous, and has been attended with little benefit, as the collateral circulation is very easily established.

In the solid forms of goitre, various methods of treatment have been attempted. Electricity, crushing, breaking up with a trocar, interstitial

¹ See *Gaz. des Hôpitaux*, 1857.

² *Lancet*, 1872; and *Transactions of Clinical Society of London*, 1874.

³ *Bulletin de Thérapeutique*, 1849.

⁴ *Transactions of the American Medical Association*, vol. iv., 1851.

injection, the seton, etc., have all been tried with the object of bringing about absorption. The biniodide ointment, used as already described, has also been employed for this form of the affection. When other means fail, excision may be thought of in favorable cases, but is a proceeding so formidable that few surgeons have had the courage to attempt it. In the words of Dr. Greene, "accurate anatomical knowledge and a perfect self-control under the most trying ordeals through which a surgeon can pass, are indispensable to its performance." Yet it has been done, and that successfully, in very formidable cases. The ligature was used by Moreau, Desault, Mayor, and others, but with very indifferent success. The knife has been preferred by some, and while in not a few cases the bleeding has been very great—so profuse as to cause the arrest of the operation—it has been successfully commanded in others without much difficulty. Some patients, however, have died of hemorrhage, either at the time of the operation or shortly afterwards; and that excision is not an operation to be undertaken by surgeons without experience in perilous undertakings, or in other than exceptional circumstances, must be admitted. It appears to have been first performed by Desault, and since then has frequently been executed both in Europe and America, and the successful cases have been about two-thirds of those operated on.¹ Greene, in 1871, described the method which, as subsequently improved by Dr. Heron Watson, of Edinburgh,² Prof. Billroth, and others, is that now generally followed. An incision is made in the middle line down to the capsule of the gland. This incision must be free, and may extend from the chin to the sternum. In this there is little bleeding. The tumor is then enucleated without opening the capsule. This is done rapidly with the finger. The lateral and anterior connections having been broken up, and the sterno-mastoid muscles held aside, the superior and inferior thyroid arteries are secured by double ligatures, where they enter the tumor at its upper and lower angles. The various veins are also tied as they are encountered round the circumference of the growth, till the whole vascular circle has been made secure. The vessels are then divided between the ligatures by which they have been tied, and the mass removed. Greene did not stop to secure the lesser vessels, but sought rapidly for the pedicle and tied it. Where the pedicle is large, or when some part of the growth cannot be isolated, the *écraseur* may be employed. The galvano-cautery has also been suggested, but the careful and systematic deligation of each vessel is the most reliable plan to follow. Primary and secondary hemorrhage are beyond doubt the most serious dangers, and these have occasioned the most appalling catastrophes when the capsule has been opened and when the vessels have not been systematically and completely secured. Shock, septicæmia, and diffuse cellulitis have also proved fatal after this operation.

Ligature of the thyroid arteries, and also of the carotid, has been employed in the treatment of goitre, when highly vascular, without the tumor being otherwise interfered with; but, as has been already said, these operations are not only difficult, but have not been attended with such success as to encourage their repetition.

When suffocation threatens a patient suffering from goitre, we have to consider whether it is due to temporary congestion which can be relieved by local depletion and the application of ice, etc., or whether, as is more usual, it arises from the permanent pressure of the growth. If there be a distended cyst, then tapping may give rapid relief; but if the tumor be solid, no aid can be thus got. Tracheotomy may be impossible from the position and size of the growth, from the displacement of the windpipe (which is so apt to occur),

¹ Kocher, *Correspondenzblatt*: Welch, *Trans. Am. Med. Assoc.*, 1878

² *Edin. Med. Journal*, Sept. 1873.

or from the presence of large bloodvessels, and even if it can be managed it may prove abortive from the low point at which the compression acts, and from the narrowing which the windpipe has undergone, or, perhaps, from the tumor having passed behind the trachea. The longitudinal division of the tissues lying over the windpipe in the middle line, or the subcutaneous severance of the aponeurosis and muscles "at the seat of greatest constriction," have been suggested, but these measures are open to very obvious objections when we consider the disposition, situation, and structure of the growth which is the cause of the pressure.

EXOPHTHALMIC GOITRE.—In that form of goitre described by Basedow and Graves, and commonly known as exophthalmic goitre, or the goitre of spasmia, the protrusion of the eyeball is a marked and characteristic feature. The patients most liable to it are females whose health has been depressed by loss of blood, feeble digestion, leucorrhœa, prolonged mental anxiety, or overwork. The heart is usually irritable, and it may have its cavities dilated and its sounds altered. The pulse is weak and rapid. There is excessive action of the great arteries in the neck, and the patient complains of throbbing in the head, tinnitus aurium, palpitation, and great nervous depression. The cause of the protrusion of the eyeballs has been much discussed. The distension of the bloodvessels within the orbit, and possibly hyperplasia of the cellular tissue and fat there, have been credited with producing this effect, while changes in the cervical ganglia of the sympathetic have also been said to account for it. No single condition, however, has been found so constantly as to properly be considered the true and invariable cause, though there seems good reason to suppose that the chief phenomena which mark the affection are referable to morbid changes in the middle and lower ganglia of the sympathetic nerve. It is, however, as bearing on the thyroid body that this curious disease comes to be spoken of here. The thyroid becomes enlarged, though rarely to any great degree. It becomes very vascular, and is often covered by large, prominent veins. It may be markedly moved by the pulsations of the neighboring great arteries, and may undergo increase with any excitement in the circulation. One lobe may be specially enlarged. It is usually soft at first, but when of long standing may become very hard and resistant. It seldom suppurates, but may inflame or break down; and if the surface gives way, a very malignant-looking sore may be the consequence. The *etiology* and *pathology* of this disease are as yet very unsatisfactorily determined, notwithstanding all the labor which has been expended on it, and the *treatment* is mainly based on an endeavor to improve the general health and recruit the blood, and so diminish the nervous exhaustion which is so marked a condition. Attention to the digestion, the diet, and the hygienic surroundings of the patient, the avoidance of mental strain, the arrest of all wasting discharges, and the administration of iron, digitalis, and strychnia, either separately or combined, or quinine and belladonna, have been found most useful. Iodine has also been employed, but it is in iron, digitalis, and strychnia that confidence is most placed. Ice has, in the early stages, been much used for this enlargement of the thyroid, and iodine, with compression, in the later conditions of the gland. The state of the thyroid will, however, depend mainly on the condition of the general health, so that it is to its amendment that attention should be chiefly directed.¹

¹ See Graves, *Clinical Medicine*; Dublin Hospital Gaz., June, 1860; Stokes, *Diseases of the Heart*; Virchow, *Die cellular Pathologie*; Laycock, *Brit. and For. Med.-Chir. Review*, 1864, and *Medical Times and Gaz.* vol. ii. 1864; Trousseau, *Clinique Médicale*; Greene, *Medical Record*, 1871; Buffalo Med. Journal, 1851; Begbie, *Practitioner*; Charcot, *Gaz. Méd. de Paris*, 1856; and Trousseau, *Ibid.*, 1862.

TUMORS OF THE THYROID.—*Adenoid growths* occasionally occur in the thyroid, and lie imbedded in its substance. They form outgrowths, and are more or less detached, and so capable of being enucleated.

Carcinoma occasionally attacks the thyroid, and that usually subsequent to its appearance in the neighborhood or elsewhere. It is very rarely seen as a primary affection, though cases of reputed cancer have been not very uncommonly reported. All forms of carcinoma have been met with in this organ, but the soft or brain-like cancer is perhaps the most common. The rapidity of growth, the great pain, the marked pressure-effects, the invasion of the skin and the parts around (especially the windpipe and pharynx), and the propagation of the disease to glands, lungs, etc., together with the disastrous influence it has on the general health, proclaim the nature of the affection. There may be sanguineous cysts formed in the carcinomatous mass; and, if the skin gives way, a malignant ulcer may be established. The great bloodvessels may be opened, and the inevitable death hastened by bleeding.

The clinical history, physical features, and progress of malignant growths of the thyroid, differentiate them from all those of a simple character, which are for the most part smooth and of rounded outline, of soft consistence (fluctuant, perhaps), of slow growth, painless for the most part, causing pressure-effects only when they have attained a great size, and not involving the overlying or surrounding parts, or the constitution.

In dealing with tumors of the thyroid, it is, of course, essential to obtain a distinct knowledge of their nature, as otherwise neither their progress nor treatment can be determined. Not only the clinical history of the growth—its origin and progress—but its exact anatomical position and its connections, together with the state of the surrounding parts and the effects it occasions, must be carefully studied and considered. Whether it occupies the whole gland or part only; in what portion of the gland it has begun, and whether it has penetrated deeply or not into the tissues; what has been its rate of progress, and whether its growth has been regular or the reverse; whether its increase has been expedited by any temporary cause, such as pregnancy, menstruation, etc.; what is its consistence at all parts of its surface; its mobility on the underlying and in the surrounding parts, and the state of the skin and bloodvessels over it; its weight, if it can be poised on the fingers; its movement with deglutition; the presence of pulsation or fremitus; the effects of forced expiratory efforts on it; its pressure-effects on windpipe, œsophagus, bloodvessels, and nerves; the presence of pain locally or at a distance, as caused by it, and the state of the general health—these, with an inquiry into any inherited tendency, or any connection by residence with specially unhealthy localities, will supply materials for a sound opinion.

The surgeon will probably determine first whether the tumor is simple or malignant, and, if simple, then what species of innocent growth it is. Cysts and solid tumors are usually easily distinguished; yet there are many cysts which, from their tenseness, the thickness or hardness of their walls, and the nature of their contents, are easily mistaken for solid growths. The shape, weight, resistance, and pressure-effects are generally characteristic, in solid tumors, and the speed with which they grow will vary according as they consist of fibrous, cartilaginous, or bony elements.

By the aspirator the contents of cysts can be determined, but it is undesirable to have recourse to puncture if not really necessary. Much irritation may thus be occasioned, and violent bleeding has sometimes given much trouble. Cysts of the thyroid are to be distinguished from congenital, unilateral, simple cysts of the neck, by their position and history, and the fact that they are firmer and not transparent, and are accompanied by an alteration in the whole thyroid body. The congenital simple cysts and the com-

pound cysts of the neck do not, as a rule, occasion the pressure-effects which result from those cysts which form in connection with the thyroid, and their movement with the trachea is not so marked. Cysts of the thyroid, too, do not show below the tongue, as congenital cysts are apt to do.

Remarkable errors have been made between highly vascular goitres and aneurismal tumors. This has been due to the presence of expansile pulsation, *souffle*, etc., in both. A careful inquiry into the mode and exact place of origin, the extent, shape, and consistence of the tumor, together with an observation of the effects of pressure applied in turn to each carotid at the root of the neck; the movements of the tumor with deglutition; the absence of any decided reducibility, or of effects detectable in the arteries beyond the growth; also, the state of the superficial veins, and, possibly, even the influence of internal treatment by iodine and tonics, will clear up the diagnosis.

The rapid enlargement which the thyroid occasionally undergoes as the result of inflammation and congestion, is easily recognized. It is seen at times as the result of injury to a pre-existing, though perhaps little observed, goitre. The violent pain increased on pressure and movement; the local signs of inflammation (heat, redness, and swelling), and the serious fever which it occasions, together with the quickly-established pressure-effects, and the influence of antiphlogistic treatment, will conjoin to distinguish it.

The chronic glandular hypertrophy and lymphoma of the neck, have had their characters fully described. In the former, the enlargements are almost always multiple and in chains, in the well-known position of the lymphatic glands. Firm or hard, painless as a rule, slow of growth, with unaltered skin, and, possibly, with concomitant evidence of a strumous diathesis, the nature of these tumors will usually be apparent. They have not the same position as that occupied by thyroid growths, do not occasion the same local effects, and do not follow the movements of the windpipe in deglutition.

SURGICAL AFFECTIONS OF THE PAROTID GLAND.

The parotid is the largest of the salivary glands, and lies on the ramus of the lower jaw, passing also deeply behind it and between it and the mastoid process, being thus in close relation with most important structures. The external carotid artery with its great terminal branches, together with the veins which accompany them, the facial nerve and its important divisions, with branches from the cervical plexus, are imbedded in it, while the internal carotid and internal jugular, the spinal accessory, glosso-pharyngeal and vagus nerves lie close to its deep surface. It is inclosed, except its pharyngeal surface, in a strong fibrous sheath, and its duct, which is a resistant, fibrous tube lined by mucous membrane, opens within the cheek opposite the second molar tooth of the upper jaw. Cellular tissue and muscle lie over or superficial to the parotid, so that it is firmly bound down and covered on its outer aspect, but the deficiency of its capsule on the deep or pharyngeal surface has an important bearing on the direction taken by pus when formed deeply within the gland, and by cancerous growths in their extension. The parotid varies considerably in size, within the limits of health, and it is occasionally the seat of inflammation and of various growths. Many absorbent glands exist over, within, and below the parotid, and as they derive lymphatic vessels from the velum and gums, they are liable to many sources of irritation.

Some authors have described a curious *sweating or distillation of salivary fluid*, from minute points in the skin over the parotid, during eating, and in one case¹ in which this was observed, it was found after death that the paro-

¹ Baillanger, Bull. de l'Acad. de Médecine. Paris, 1847.

tid ducts were obliterated; yet Brown-Séquard¹ and others have tried to disprove the nature of the transudation, and to show that it is mere perspiration escaping in excessive quantity.

PAROTITIS, or mumps, is a common affection which attacks one gland, or occasionally both, and that simultaneously or in succession, in young males chiefly, and which at times assumes an epidemic character. It is most common before puberty, but has been observed not only in adults but even beyond middle life. In schools and public institutions it has now and then affected large numbers, especially in spring and autumn, when cold and damp have been thought to originate it. Its exact pathology has been much discussed.² It has been ascribed to rheumatism, has been classed with the eruptive fevers, and, as it is commonly preceded or accompanied by inflammation of the fauces, has been thought by many, in all cases, to proceed by continuity of tissue along the duct. It reaches its acme in two or three days, and in eight or ten days it disappears. Parotitis causes considerable local swelling, which, however, may so spread as to involve the whole side of the neck, especially if the other salivary glands become affected, as they sometimes do. There is no heat or redness, but the pain is considerable, especially during mastication and deglutition. This pain is little if at all aggravated by pressure, as long as no suppuration follows. The attack may be ushered in by chills, sickness, headache, and elevated temperature, and by so much constitutional disturbance as to deceive the practitioner regarding the nature of the ailment, and lead him to expect some serious eruptive fever; but this only occurs in exceptional cases, as in general there is little or no fever present from first to last. The transference of the inflammation from the parotid to the testicle or mamma, which occasionally (in 2 or 3 per cent. of the cases) occurs about the fifth or sixth day of the attack, is a curious and unaccountable complication of this ailment. It is not as often seen to involve the mammary gland as the testicle, but it does so occasionally, and may implicate the uterus and ovaries as well. The parotitis more rarely follows the orchitis.³ The testicle on the same side as the affected parotid is that usually involved, but this is not always the case. The transference is most often observed in patients who are of somewhat advanced age. Of late years attempts have been made to throw doubt on this "metastasis," as it has been called, to the testicle, and to allege that when orchitis has appeared there has always been a latent gonorrhœa. I have had most conclusive evidence of the untenableness of this view, but am inclined to think that masturbation during the attack of mumps, had, at least in one case, some influence in attracting the inflammation to the testes. Various other complications in the ear, eye, tonsils, and brain, have been recorded as following parotitis.⁴

Mumps as a rule subsides spontaneously, and leaves no harm behind, unless a little thickening which disappears in a short time if not interfered with. A blister may occasionally, however, be thought desirable, to hasten the dispersion of the condensation.

As to the *treatment* of the ordinary simple parotitis, little need be said, as rest of the part (using soft food), fomentations, simple or medicated with chamomile flowers, and the use of a saline, are all the remedies which it usually demands. Liniments containing belladonna, camphor, or iodine, are frequently employed after the acute stage. The soap and opium liniment, alone

¹ Journal de Physiol., tome ii.

² Trousseau, Clinique Médicale; Pitha und Bilioth, Handbuch, Bd. iii. S. 373; Gosselin, Clinique; and Vidal, "Des Oreillons."

³ Billoir, Gaz. des Hôpitaux, 1850.

⁴ Trousseau, Archives Générales de Médecine, 1854.

or combined with chloroform liniment, twice as much of the former as of the latter, does very well to remove the stiffness which remains. Leeches and cold are not used, and blisters are seldom required. If the inflammation in a lymphatic gland, however, were very acute, of course local depletion might be useful. Many prefer to cover a simple swelled parotid with cotton wadding, and to abstain from all active local treatment. As a rule, I have myself found this quite sufficient.

The orchitis which occasionally arises during the course of parotitis is easily managed. Rest, fomentations, and elevation of the part, will soon subdue it. Leeches, if used, assist the induction of that atrophy which occasionally follows, and therefore should not be applied. Leeches too are very troublesome when applied to the serotum or cord. Blisters and caustics are even more objectionable. It is useless to try and attract the inflammation again to the parotid, by blisters applied to it, if the testis be already involved. Time and rest will do more than active treatment to secure an effectual and safe recovery. The administration of mercury and iodide of potassium, as recommended by some, is unnecessary.

SUPPURATIVE PAROTITIS (*Parotid Bubo*).—In weakly subjects, and in depressed conditions, as after child-birth, erysipelas, typhoid fever, diphtheria, and smallpox, or in the course of septicæmia, from a too prolonged course of mercury, or from closure of Steno's duct, suppuration may occur in the parotid after an attack of acute "phlegmonous" inflammation within the gland, and it is not so very unusual for it to implicate the cellular tissue which lies over it. The pus, when formed within the strong capsule of the gland, has great difficulty in coming to the surface, and may work havoc in various directions. It may pass downwards even into the chest, upwards along the sheath of the vessel into the skull, backwards behind the pharynx, or into the ear and the articulation of the lower jaw. It is therefore necessary to give early vent to an abscess situated in the parotid. If the pus lies external to the gland, the incision made should correspond in direction to the course of the facial nerve, but if the gland has to be cut into, the knife should be carried parallel to the external carotid, one or more of whose branches may possibly be wounded notwithstanding every care. A director and dressing forceps should be employed to reach the pus if it be deep, and antiseptic dressings should be used, as violent and dangerous bleeding, thrombosis, and blood-poisoning have followed deep wounds in the parotid. Sloughing, and even what has been designated as mortification, have been seen after violent inflammation, and this will be the more readily produced if, when an abscess forms, early and effectual drainage be not secured. It is not in the parotid gland that inflammation leading to troublesome suppuration is so commonly seen, as in the lymphatic glands which lie in and especially below the parotid. Such inflammation causes the usual local signs of its presence. The redness is occasionally erysipelatous, while there is heat, with acute pain increased on pressure and movement. There is also marked constitutional disturbance. The swelling is often great, and the cavity of the mouth inflamed, while the pressure caused by the swelling may not only occasion great pain and tension, but may interfere with the return of blood from the brain, and so bring on delirium and other troublesome symptoms. The pus has a horrid fetor from being mixed with air, and it may collect in one large or several small abscesses. Recovery is often protracted, and relapses are not unfrequent. Disagreeable marking, parotid fistula, and facial paralysis may eventuate from extensive suppuration in this region. If the inflammation is acute, it will require to be promptly and actively treated by leeches and repeated blisters, and if pus forms, by an early incision.

PAROTID FISTULA.—Steno's duct may become occluded either by adhesions following acute inflammation—as in violent salivation, or during the healing of wounds—or by calculi (phosphatic) which sometimes form within it. A more or less complete arrest of the flow of saliva will result, and an oval fluctuating tumor will form in the line of the duct. The size of this cyst-like tumor will probably be seen to increase during mastication, and, if it burst externally, a salivary fistula may be established. *Fistulæ* may either be connected with the parotid itself, and be placed over some part of its surface, or in its neighborhood though beyond its limits; or they may open into Steno's duct.¹ The orifice of the fistula may be so small as to be difficult of detection unless it be elevated, as it sometimes is, on a small papilla, or sunk into a little pit, or unless it be red and irritated by the discharge, so as to mark its presence. The flow of the saliva may be readily increased by the patient chewing some pungent substance, or placing a bit of lemon on the tongue, and then the distillation of the saliva by the orifice may be seen, and the nature of the secretion exactly determined by chemical tests. If the external orifice is large enough to allow of a colored injection (milk, or a solution of iodine) being thrown along the duct into the mouth, or in the reverse way, or of a probe being passed through it, then all doubt will be removed. Small fistulæ connected with the gland are usually cured easily, if seen early. In truth, they not unfrequently close spontaneously, if any obstruction which was present is removed, but fistulous orifices connected with Steno's duct, especially if long open, are very difficult to rectify. The application of various caustics, especially a pointed piece of lunar caustic, is a favorite and simple remedy which in slight cases may succeed, especially if combined with well-adjusted pressure and rest to the part. The galvanic cautery at a low heat, or a hot needle, is however more reliable. All sorts of injections have also been used—wine, alcohol, caustic solutions, iron, iodine, etc.—but little advantage follows their employment. In fistula of the duct an infinite number of remedies have been suggested. Some aim at re-establishing the duct, if partially or wholly closed; some aim at forming a new orifice for the duct within the mouth; some try to arrest the secretion of the saliva by destroying the parotid gland; and others employ various methods for merely closing the opening on the cheek by plastic or other operations.

If the duct is obstructed between the fistulous opening and the mouth, a fine leaden probe, or a firm piece of catgut, may possibly be passed from the mouth along the duct and beyond the fistula, so as to act as a conductor for the saliva, and thus allow the abnormal aperture to close or be dealt with by the surgeon. Setons of wire, silk, etc., have been used in the same way.

A new orifice within the cheek has been secured in various ways. A seton of wire, catgut, cotton, lead, or other material; a trocar and canula (the latter being left in place); the bistoury, followed by a tent, have all been used for this purpose. Deguise's plan has secured considerable favor. He passed a small trocar from the fistulous orifice inwards and backwards, and passed the end of a leaden wire. The trocar was then passed a second time from the original point of introduction, but this time it was carried in the direction of the duct, and the other end of the wire was passed into the mouth. The two free ends of the leaden wire, which now projected into the mouth, were then twisted together within the cheek, thus constricting some of its substance. The external orifice was next closed by the ordinary twisted suture, and its edges became adherent in a few days as the saliva escaped into the mouth along the wires, which were finally removed as the

¹ Duparcque, *Revue Médicale*, 1842; and *Mém. de la Soc. de Chir.*, tome ii.; Jarjavay, *Ibid.*, tome iii.

apertures along which they had passed became permanently established as internal openings. Threads of gold, silver, silk, and catgut, have been substituted for the lead, and additional means have been used to constrict and divide the piece of soft tissue inclosed in the loop, without improving De-guise's method.

Langenbeck and Van Buren dissected out the extremity of the duct where it opened on the cheek, with a margin of the surrounding tissue, and carried the whole through the cheek into the mouth, fixing it there for some weeks by fine wire sutures, while the outer wound was closed. Professor Horner attained the same end by placing a broad wooden spatula in the mouth, to protect the tongue, and then removing entirely the fistulous orifice with a large sharp punch, so as to drive a hole right through the cheek. The outer wound was then united by the twisted suture.

Maisonneuve tried to cut off the flow of saliva from the parotid, by applying pressure between it and the fistulous opening, and it has been asserted that pressure applied to the parotid itself has brought about its atrophy, and thus arrested the stream of salivary fluid which escaped. These latter remedies, however, need hardly be discussed. Finally, autoplasmic operations may be resorted to if an internal orifice have been secured, and if the external opening cannot be otherwise closed.

If a *calculus* is impacted in the duct, its presence can easily be recognized by the swelling and discomfort which it occasions, and by an examination made with one finger within the mouth, and another outside the cheek. These calculi are of an elongated shape, and lie in the axis of the duct. They should be at once removed by a free incision on the buccal surface, while pressure is kept up by the finger outside. They may, if left, occasion the formation of a fistula, by setting up ulceration.

TUMORS OF THE PAROTID.—The parotid is occasionally the seat of various tumors of a simple or malignant kind. They may consist of one element, but they are more usually mixed. The simple growths are either mere hypertrophy, which is very rare indeed, or consist of fibrous, cartilaginous, adenoid, fatty, and myxomatous elements. Of malignant tumors, carcinoma is not very rare, while sarcoma is occasionally seen, and the recurrent fibrons [spindle-celled sarcoma] is also met with. Cysts have their seat at times in this region, and these different neoplasms may be variously combined. The lymphatic glands lying over and in the parotid, may become the seat of enlargement, or may be altered in structure; and in this way the surgeon has at times no easy task to distinguish with accuracy the nature of the tumor which he is called upon to treat.

It is by a consideration of the clinical history and physical characters of the tumor, and of its effects on neighboring structures, as well as by observing the age and condition of health of the patient, that a surgeon is chiefly guided in his opinion. The slow, painless growth in an outward direction; the absence of close adhesion to the parts below, above, and around, so that the fingers can, as it were, be inserted below the tumor, and separate it from its surroundings; the healthy condition of the distended skin; the non-existence of facial paralysis and lymphatic gland-irritation as well as of other pressure-effects, and the non-involvement of the general health, would point to the tumor being innocent. The cancers again contrast in all respects with such growths, but in varying degrees according to their special forms. The hard, ill-defined tumors which appear under the ear in persons at or after middle life, early fixed (especially laterally), with pain flashing up to the temple and down the side of the neck, markedly compressing surrounding structures and so interfering with their function, growing rapidly, involving the

skin and making it coarse and dark-colored before it gives way, and establishing in time the broad-spreading, deep, characteristic, bleeding ulcer, with hardened chain of glands and dilated veins, with facial paralysis and early embarrassment of deglutition and mastication, very plainly point to the hard and condensed form of carcinoma. Between these two extremes there will be found many diversities and combinations. Carcinomata of the soft form, myxomata, cysts, and cartilaginous tumors, occur mostly in young persons; fibrous and sarcomatous growths before middle life; and hard cancers and epitheliomata in old age. Soft cancers, lymphomata, and sarcomata grow most quickly, and fatty, fibrous, and cartilaginous tumors most slowly.

The shape, outline, and consistence of the tumor, the presence or absence of lobulation, its rapidity and regularity of increase, its size, the state of the overlying skin, the interference of the tumor with function, together with the age and health of the patient, and possibly the family history, will chiefly aid the surgeon in distinguishing the species of growth with which he has to deal.

Simple hypertrophy of the parotid is very rare. The case related by Bérard,¹ and verified after the death of the young patient, and one or two others whose exact nature was not determined, make up the sum of such cases.²

The "*glandular parotid tumor*" is perhaps that with which the surgeon is best acquainted. Its pathology has been much debated. At one time it was thought to spring from a lymphatic gland lying in contact with the parotid, at another to be always due to a growth of the parotid gland itself, or of its fibrous envelope.³ The common parotid tumor is fibrous or glandular for the most part, but has mixed with it cartilaginous masses and often cysts. It compresses the parotid more or less, and may occasion its atrophy and almost total absorption, so that when it is removed a deceptive appearance is produced of the parotid having been excised. These tumors often attain a great size, and are yet movable and but loosely connected. Their surface is irregular, tuberos, lobed, or round, firm and hard at most points, but elastic at others. The skin, though marked by enlarged veins, is not involved or adherent. They lie below, in front of, and behind the ear, and grow slowly and perhaps capriciously, or remain stationary for years. They have no effect on the general health, and cause little pressure as a rule, though facial paralysis, impediment to the venous return from the head, and embarrassment of swallowing and chewing, have in rare cases been observed.

Parotid tumors rarely consist of pure *cartilage*, but the great bulk of them may be formed of that structure, and when soft and quick-growing, as they are in exceptional cases, they may recur after excision. They may be wholly buried in the gland, or be merely pressed into it and covered by the fascia, and the facial nerve may pass through them, be spread over them, or be firmly adherent to their under surface. They usually appear about middle life, and are generally innocent.

The only effectual remedy for these growths is removal, and if they are growing, the sooner this is effected the better, as with increased size comes augmented difficulty. The method of excising them will be hereafter described.

Lipomata are occasionally met with, over, within, and below the parotid, and are recognized by their well-known characters. *Nævi* also occur over the gland, and *cysts* (serous, sanguineous, sebaceous, and compound) form here as elsewhere, but do not demand special description.⁴

¹ Thèse de Concours, 1841.

² Vidal, *Traité de Pathologie Externe*, tome iii. p. 669-70.

³ Bérard, Thèse; Bauchet, *Mém. de la Soc. de Chir.*, Juin, 1856; Dolbeau, *Mémoire sur les enchondrômes de la parotide*, *Gaz. Hebdom.*, 1858.

⁴ See Paget, *Lectures on Surgical Pathology*, 3d edit. 1870.

Carcinoma is not as common an affection of the parotid as was at one time supposed, when no distinction was drawn between it and sarcoma, enchondroma, fibro-plastic and other tumors. All forms of carcinoma have been met with here. The clinical characters of such growths have already been referred to. *Sarcoma* is more common than carcinoma, and cannot in many cases be distinguished from it by its history, or physical and vital effects; but as a rule it does not exert as much pressure, does not involve and destroy the skin in the same way, and does not poison the blood. But sarcoma may show marked local malignancy and return after excision, though as to this we cannot express an opinion till the histological elements of the tumor have been examined. The excision of malignant growths of the parotid is beyond our art, and should not be attempted. They insinuate themselves in and around the important structures in their neighborhood, and backwards toward the pharynx, in a way hardly to be recognized before the parts are opened up. Even after death, it has been found impossible to effect a separation of their prolongations without great destruction of surrounding parts. It has been found impracticable to discover even whether the internal carotid artery, and hypoglossal and other nerves, were not involved, and portions of the growth have been found after death to penetrate the internal jugular vein, without any sign of such a complication having been visible during life. Notwithstanding these considerations, it must yet be allowed that cases are recorded in which the excision of a cancerous parotid is said to have been successfully performed. This point, however, will be again alluded to.

Pure *myxomas* are very rare in the parotid. No distinction, which is of much clinical value, can be drawn between them and sarcomatous growths. They are usually softer and more diffuse, that is, less circumscribed, and more apparently fluctuating.

The *lymphatic glands* lying in contact with the parotid may enlarge and suppurate, or may assume the characters of lymphadenoma and lympho-sarcoma. In the latter case it is only by the clinical history and progress of the tumor, and by an examination of its histological elements, that its true nature can be recognized. Tumors lying over the parotid will, till they attain a considerable size and anchor themselves more firmly, be much more movable than those found in the gland itself—that is, below the strong sheath which incloses the gland—and it is chiefly by observing this mobility, and their greater diffuseness and less limitation to the area of the parotid, that the true seat of the growth is determined.

As to the excision of tumors lying over, or in, the parotid gland—fibrous, cartilaginous, glandular, etc.—it may be said that in many cases the operation is easy enough, though from the size and appearance of the tumor beforehand it may appear very formidable. If, however, there are deep and irregular prolongations of the growth, as when it grows within the capsule of the parotid, and if these have formed close connections with the bloodvessels and nerves behind and below the angle of the jaw, then no operation can be more difficult or dangerous. Mere size is no contra-indication to an operation. Tumors in this region have been removed successfully, which have masked the whole side of the neck. In many cases the bulk is due to the increase of the tumor being solely in an outward direction. The mobility and circumscription of the growth; the possibility of inserting the fingers below it, and, as it were, raising it up; the freedom from pressure-effects on bloodvessels and nerves; the healthy state of the skin and the lymphatic glands; the rate and direction of the tumor's increase, together with the age and state of health of the patient, and the possibility of removing the whole mass, will chiefly influence the judgment in determining for or against an operation.

In excising simple growths, the overlying parts should be freely divided down to the tumor itself. If it is encapsuled, the growth should then be enucleated with as little dissection as possible—the finger and handle of the knife being chiefly employed. An incision passing down the posterior surface of the tumor, and another leaving the first at either its centre or lower end, and running forwards, generally best meet the requirements of these cases. If deep dissection be required, the parts to be divided should be scraped through only after careful inspection, and the securing of each doubtful portion by two ligatures before division. Drainage must be very carefully provided for, and no skin should be removed unless it be diseased. If important bloodvessels running through the tumor are divided, they can be secured without much difficulty, and it is well to dissect from below upwards (as all operators have stated), and from behind forwards, so as to tie at once the main bloodvessels which are necessarily cut, and not have to ligature them again and again in the course of the operation. It has been shown that if the main trunk of the facial nerve be divided, and its cut ends placed together, the function of the nerve will be restored. It would be well in such a case to unite the extremities of the nerve by suture. The common carotid is not now tied as formerly, preparatory to the excision of tumors of the parotid, and the use of the *éraseur* and galvano-cautery is seldom thought of, though the latter instrument might, in complicated cases, be found of much use.

It is right to add that the possibility of excising the parotid has been the subject of much controversy. That in its unchanged condition it is impossible to define accurately its limits so as to take it all away without injury to surrounding structures, has been asserted since Allan Burns and others studied the question; but that it can be removed when so altered by disease as to become more defined, prominent, and prehensible, must be admitted.¹ Nélaton, Malgaigne, and many others have taken a prominent part in this discussion, but the terms of the question debated have not always been identical. To excise a sound, unchanged parotid, and one affected with cancer, are very different things; and these again differ widely from dealing with a parotid, the seat of affections which have not the tendency to burst the capsule of the gland, and spread far and wide, working themselves into the surrounding parts as malignant tumors do. It is from not observing this difference in the problem, that much of the diversity of opinion which is so copiously expressed in the writings of several authors has arisen.² It is not necessary here to enter on this question. In America, excision of the diseased parotid has been, perhaps, more frequently reported than elsewhere. Warren of Boston, in 1798, led the way, and McClellan, of Philadelphia, several times repeated the operation. Many cases (over one hundred) are on record in which it is said to have been performed, but there is strong reason to suppose that in a certain proportion of these it was not the gland itself, but a tumor deeply imbedded in it, which was removed. Malgaigne, in his report to the Academy, even went the length of asserting that the diseased parotid could be excised without injuring either the external carotid or the facial nerve. Paralysis of the *portio dura* may, however, be always looked for when the parotid is seriously dealt with, and the bleeding cannot fail to be very severe, so that it is in any case an operation which demands experience and mature knowledge in the surgeon who undertakes it. The incision employed is usually a straight one, but it may assume other directions to suit the

¹ See Bérard, Des opérations que réclament les tumeurs développées dans la région parotidienne. 1841.

² Bulletin de l'Académie de Médecine, Octobre, 1858.

case in hand. A Γ -shaped or J -shaped wound is often preferred. It should freely expose the mass, and should make ample provision for drainage. The tumor is best detached from below and behind, upwards and forwards, though Malgaigne and others dissected it from above. It is in dealing with the back of the growth that difficulties chiefly arise. The surgeon must keep close to the tumor, and examine well every fibre before dividing it, scratching and tearing, rather than cutting. The digastric muscle may have to be severed, and each vessel opened must be at once secured. It has been found comparatively easy to compress and tie the external carotid as it enters the tumor. It should be tied with a double ligature. Malgaigne shows how opening the mouth freely, enlarges the space behind the angle of the jaw, and so facilitates the separation of the deeper portions of the growth. If too much traction be made, the internal carotid and jugular may be so displaced as to come within the field of operation. This should be carefully avoided. The large terminal branches of the external carotid will be cut as the upper end of the tumor is detached. The facial nerve cannot escape, unless the growth be so friable that it can be teased out.

Ligature of the carotid, in order to induce atrophy of the parotid gland, has not been found to succeed, from the great freedom of anastomosis; and removal of the gland by ligature and caustic has signally failed.

AFFECTIONS OF THE SUBMAXILLARY GLAND.

The submaxillary gland resembles the parotid in respect to the growths to which it is liable. It is inclosed in a very perfect fibrous capsule, derived from the cervical fascia. Its duct ("Wharton's") may be obstructed by calculi of the same chemical composition as those found in Steno's duct; and in consequence of inflammatory adhesions, the escape of saliva may be so impeded, that a soft, fluctuating swelling forms in the floor of the mouth, due to its accumulation. This is not ranula, but was long confused with it. If from any cause the secretion from the submaxillary duct does not get free vent, engorgement, and (if prolonged) permanent enlargement, of the gland may be caused. The presence of a concretion is best made out by placing one finger in the floor of the mouth and one below the jaw, so as to compress the duct between the fingers, and then rolling one finger on the other. Much swelling and uneasiness may arise from the presence of such a foreign body. In mumps, the submaxillary gland may participate, and may become swelled and painful.

Inflammation of the submaxillary gland may follow the irritation induced by a piece of dead bone in its neighborhood, or by a carious tooth or violent stomatitis. It is, however, the lymphatic glands which abound in the neighborhood of the submaxillary, which are most usually affected by such causes, and which simulate an affection of the submaxillary itself; and there is every reason to think that in not a few cases in which growths have been supposed to be seated in the submaxillary gland, calling for its excision, it has been the lymphatic glands which have been really involved, and which have been removed.

Cysts, adenoma, enchondroma, fibroma, sarcoma, lymphoma, and sarcomphoma have been occasionally met with in the submaxillary gland. Paget declares that enchondroma is not as common in the submaxillary as in the parotid, and in this he certainly expresses the opinion of most, if not of all, surgeons. Submaxillary growths may attain a considerable size, pressing upwards into the floor of the mouth, and so causing embarrassment of function by their bulk; and even, in rare cases, compressing the pneumogastric

and sympathetic nerves, and so causing, with other signs, dilatation of the pupil. The windpipe and œsophagus have also been pressed upon by these tumors.

Carcinoma is rare as a primary affection in the submaxillary gland, but it may extend from neighboring parts to this with other structures. It is, however, in the surrounding absorbent glands that this disease is most usually met with. Cancer causes much pain, and occasions a hard, fixed, irregular mass, which soon involves the skin and mucous membrane, and ends in foul ulceration. If it grows to any size, it produces pressure, and may at an early date arrest the flow of saliva from the affected gland. The absorbent glands quickly participate, and the whole of the parts are matted together in one mass. To remove a submaxillary gland so affected is no easy matter, and by the time the true nature of the disease is fully recognized and an operation determined on, it is usually hopeless as regards the saving of life. Jobert (de Lamballe¹) and others, are said to have removed small cancerous tumors of the submaxillary through the mouth, without any external excision, but they must have been of trifling size, little adherent, and of a simplicity seldom encountered. The drainage would necessarily be bad, the difficulties great if the tumor were of any considerable bulk, and the advantage over the usual operation, below the jaw, difficult to discover. Unless the tumor has attained a large size, it is not a formidable operation to remove it by an external incision. The facial artery, which lies on or in the substance of the gland, is the only vessel which is likely to give trouble. It is best tied before the growth is moved from its bed. The hypoglossal and lingual nerves can be easily avoided, and the branch of the lingual artery which is cut can be readily secured.

¹ *Gaz. des Hôpitaux*, 1849.

INJURIES AND DISEASES OF THE AIR-PASSAGES.

BY

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LARYNGOSCOPY.

LARYNGOSCOPY—inspection of the interior of the larynx—is effected by means of a small mirror so mounted as to be readily passed into the mouth and placed in a position which will reflect the image of the larynx. The same principle has long been employed by the dentist to obtain images of such portions of a tooth as are out of the line of direct inspection. It is to the experiments of Manuel Garcia, of London, a teacher of singing, that modern surgery is indebted for a knowledge of the laryngoscope;¹ it is to Prof. Czermak, of Pesth, that is due its reception into the medico-chirurgical armamentarium;² and it is to Prof. Tuerck, of Vienna, that medicine is chiefly indebted for copious clinical representations of its great usefulness in diagnosis and treatment.³

All that is needed to examine the larynx and adjoining structures, in the presence of a good light, is a good glass mirror, mounted on a rod firm enough to resist being bent by the muscular action of the soft palate. A circular mirror one inch in diameter (Fig. 1107) will suffice for most purposes in the adult. Smaller mirrors are sometimes needed with adults, and almost always with children.

Fig. 1107.



Laryngoscopic mirror.

The position of the mirror in the mouth, and the general features of the image of the normal larynx as seen in it, are fairly represented in Fig. 1108. The manipulation of the laryngoscopic mirror may be briefly described as follows: The mouth of the patient being well illuminated by natural or

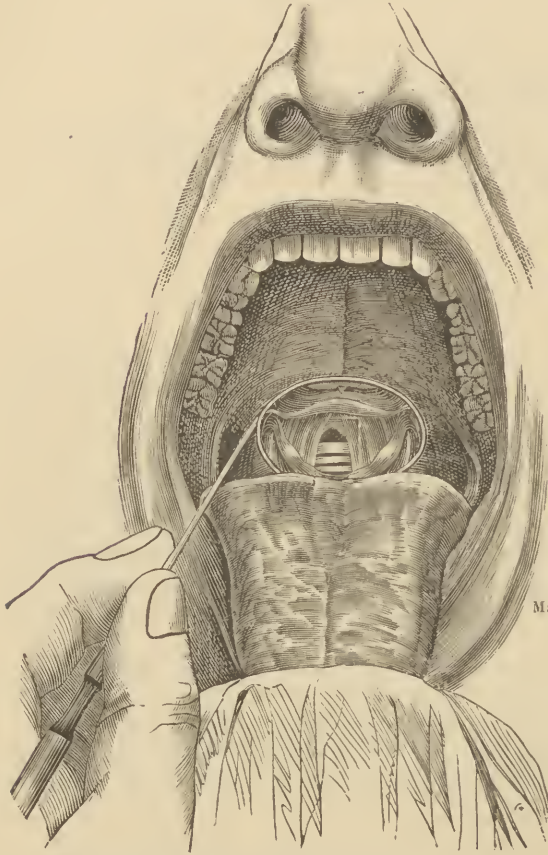
¹ Physiological Observations on the Human Voice. Proc. Royal Soc., vol. vii. No. 13, p. 399. London, 1855.

² Wien med. Woch., No. 13, März, 1858; Der Kehlkopfspiegel und seine Verwerthung für Physiologie und Medizin. Leipzig, 1860.

³ Klinik der Krankheiten des Kehlkopfes und der Luftröhre. Wien, 1866.

artificial light, direct or reflected as may be most convenient at the moment, the patient is directed to open his mouth, to put out his tongue as far as possible, and to prevent his tongue from slipping back by holding it in a fold of a handkerchief or napkin (Fig. 1108). The surgeon, with his mirror in hand much as he would hold a pencil (Fig. 1109), warms the glass over

Fig. 1108.



Laryngoscopic mirror in position. The tongue extended, and held with a napkin.

Fig. 1109.



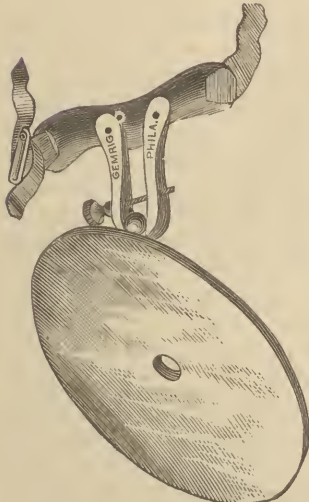
Manner of holding a laryngoscopic mirror.

the flame of an alcohol lamp or gas jet, to prevent condensation of the breath on its surface, and then passes the mirror into the mouth, reflecting surface downward, and rests it against the soft palate, which he lifts slightly with the uvula on the back of the mirror. The reflecting surface now presents itself obliquely forward and downward, and shows an image of the parts in front of it and below. By moving the mirror gently, the image is changed from point to point until the inspection has been completed. With a steady hand and a little practice, the larynx can be thus examined at once in the great majority of instances. Repeated attempts are necessary, at intervals of a few moments of rest, with nervous subjects, and in cases of hypersensitiveness of the parts from disease. For the minute details of manipulation the reader must be referred to manuals of laryngoscopy and of diseases of the throat.

When examinations are made with daylight, the parts appear in their true colors, which are much paler than the colors produced by artificial light. When direct daylight cannot be used, the diffuse daylight may be concen-

trated upon the interior of the month and throat by means of a concave reflector similar to those used in ophthalmoscopy (Fig. 1110), which may be held in the hand, or may be attached to the head. The same kind of reflector is used with artificial light, a combined illumination practised more frequently than any other, and then the reflector may be conveniently attached to either a lamp (Fig. 1111) or a gas-bracket. Various lanterns, or light-concentrators, are used for illuminating purposes, but a good naked gaslight answers admirably, and a coal-oil light is still more satisfactory. The lanterns, whether for coal-oil, gas, oxy-hydrogen, or electric lights, are not needed for ordinary purposes. The brightest light available is sunlight, direct, or reflected from the surface of a plane mirror.

Fig. 1110.



Perforated reflector for laryngoscopy,
with band for attachment to head.

Fig. 1111.



Laryngoscopy by reflected artificial light. Method of Tobold.
(Tobold.)

The image of the structures thus to be inspected by laryngoscopy requires some little preliminary study on the normal subject, or on the excised larynx, to be fully comprehended; for it appears in a position nearly vertical, while the natural plane is much more horizontal. Then, too, there is an apparent antero-posterior reversal of position, with maintenance of the actual lateral relations of left and right.

The structures which can be inspected laryngoscopically are, from before backward and downward: The posterior portion of the base of the tongue; the posterior surfaces of the anterior palatine folds, and their attachment to the sides of the base of the tongue; the lateral ligaments connecting the tongue with the hyoid bone; the ligaments connecting the tongue with the epiglottis, together with the lingual sinuses on either side of the middle glosso-epiglottic ligament; the tonsils; the posterior palatine folds; the ligaments connecting the epiglottis with the hyoid bone; the epiglottis, on both lingual and laryngeal surfaces; the aryteno-epiglottic folds forming the lateral borders of the entrance into the respiratory portion of the larynx; the arytenoid and supra-arytenoid (Santorini) cartilages; the posterior or arytenoidal vocal processes, extending into the structure of the vocal bands; the base and sometimes more of the cuneiform (Wrisberg) cartilages; the laryngo-pharyngeal sinuses between the wings of the thyroid cartilage and the soft lateral walls of the laryngeal tube; the posterior wall of the

pharynx down to its transition into the œsophagus; the posterior wall of the larynx down to where the pharynx merges into the œsophagus; the supra-glottic portion of the interior of the larynx; the vocal bands (true vocal cords), the laryngeal ventricles (Morgagni) above them, and the ventricular bands (false vocal cords) above the ventricles; the infra-glottic portion of the cavity of the larynx to a variable extent, and the internal face of the anterior portion of the thyroid cartilage, crico-thyroid membrane and cricoid cartilage; the anterior portion of the trachea in variable extent, clear down to its bifurcation under favorable anatomical relations; a portion of the interior of the right bronchus under exceptional normal conditions; and more or less of the posterior wall of the trachea.

WOUNDS AND SCALDS OF THE LARYNX AND TRACHEA.

Wounds of the larynx and trachea occur as results both of external and internal injuries. Wounds from external injuries usually, but not invariably, implicate the integument by solution of its continuity. They are usually attended by extensive hemorrhagic extravasations into the abundant loose connective tissue. They are frequently complicated by fractures of the cartilages. They are occasionally complicated by wounds of the great cervical bloodvessels and nerves. Wounds from internal injury almost always implicate the mucous membrane in the first instance; in rare instances they may penetrate the cartilage; even a wound of the carotid artery has been known to occur in this manner.

Wounds of external origin present themselves in the usual varieties of contused, punctured, incised, lacerated, and gunshot wounds. Wounds of internal origin present themselves mostly as lacerated, but occasionally as punctured wounds. They are usually the result of injury by a foreign body in the air-passage.

Scalds or burns may be caused by hot or caustic fluids swallowed accidentally or designedly, or by flame or hot air inhaled from burning buildings or ships.

I. WOUNDS OF THE LARYNX AND TRACHEA.

WOUNDS OF EXTERNAL ORIGIN.—*Contused wounds of the larynx* are usually produced by intentional blows upon the throat with the fist or a weapon, by kicks from men or beasts, by accidental blows from hard objects, or falls upon them, or by attempts at strangulation, whether with hands, with cloth, or with rope. They are liable to cause considerable extravasations of blood into the submucous and intermuscular connective tissue. In some instances the injury is sustained by the soft parts only. Some cases are complicated with fracture of the cartilage—simple, or even comminuted—occasionally the cricoid, but more frequently the thyroid. These fractures may be anterior or lateral, and are usually vertical, or nearly so.¹ Other complications comprise rupture of the ligaments and connecting membranes of the different components of the laryngeal skeleton; rupture or laceration of the vocal bands, mucous membrane, and other soft tissues; fracture of the cornua of the hyoid bone; dislocation of an arytenoid cartilage; and contusion, rupture, or other injury to the trachea.

Contused wounds of the trachea occur from the same class of causes as similar

¹ See Fractures.

wounds of the larynx. They are usually associated with rupture of one or more intercartilaginous ligaments, or with rupture of the trachea from the cricoid cartilage. Sometimes they are associated with longitudinal fractures of one or more rings; and sometimes with comminuted fractures, as when the result of crushing violence.¹ Sometimes they are associated with laceration or rupture of the membranous wall, either with or without perforation into the œsophagus. Hemorrhagic extravasations may be very extensive. In most instances these wounds are associated with wounds of the larynx, similar or still more severe.

Punctured wounds of the larynx are usually accidental, as from falls upon pointed objects. Legouest² has reported one in which the tine of a pitchfork perforated the larynx from right to left. Sometimes they are the result of homicidal attacks with sharp or pointed weapons; occasionally they are suicidal. Modern military records seem to furnish few examples of bayonet wound of the air-passage. Only nine bayonet or sabre-wounds of the neck are recorded in the History of the War of the Rebellion, and in none of these had the air-passage been implicated. Durham, however,³ relates the case of a patient under his care in Guy's Hospital, London, whose larynx had been wounded by a bayonet during this war. According to the same author, punctured wounds through the thyroid cartilage occasionally penetrate between the vocal bands, or injure one or both of them; œdema of the glottis(?) ensuing almost invariably, and producing death by suffocation. A case is quoted from Sir Charles Bell in which suffocation from exuberant granulations ensued some months after a wound in this situation, inflicted with a penknife. The wound in the integument may be trifling. Emphysema is a frequent complication, and may produce severe dyspnoea.

Punctured wounds of the trachea are due to the same class of causes as are punctured wounds of the larynx. Beach⁴ has reported a case of perforation of the trachea by the tine of a pitchfork. Such an injury from a sword has been recorded by Paré,⁵ and one from the point of a closed pair of scissors, by W. F. Atlee.⁶ Three instances of penetration of the trachea in injecting bronchocele have been mentioned by Mackenzie,⁷ in one of which persistent hæmoptysis ensued. Emphysema of the neck is quite a common result in punctured wounds of the trachea, and general emphysema may reach alarming proportions within a few hours.⁸

Incised wounds of the larynx are more frequent than those of all other varieties together. Surgical wounds for operative purposes will not be discussed in this connection. Incised wounds may involve not only the integument and the structures of the air-passages, but also the muscles, bloodvessels, nerves, submaxillary glands, and tongue. Occasionally accidental, as in falling upon a sharp object, such as a fragment of glass or crockery, and sometimes due to homicidal attacks, most wounds of this class are suicidal. In some wars they are produced by sabre-cuts. (Paré, Legouest.)⁹ It has been estimated statistically that of 4595 suicides in France, 125 had cut their throats;¹⁰ and that of 6696 cases of suicide in England, between 1863 and 1867, 1235 were cases of cut-throat.¹¹

Quite a large proportion of suicidal wounds are seen in insane subjects and

¹ See Fractures.

² Horteloup, Plaies du larynx, de la trachée et de l'œsophage, p. 51. Paris, 1869.

³ Holmes's System of Surgery, vol. i. p. 689. Am. ed., 1882.

⁴ New York Med. Jour., March, 1877, p. 302.

⁵ Œuvres complètes, éd. par Malgaigne, t. iv., liv. 8, chap. xxx.; Mackenzie, Diseases of the Throat and Nose, vol. i. p. 540. London, 1880.

⁶ Am. Jour. Med. Sciences, April, 1878, p. 439.

⁷ Beach, loc. cit.

⁸ Brierre de Boismont, Du Suicide. Paris, 1856.

⁹ Op. cit., p. 540, note.

¹⁰ Horteloup, op. cit., pp. 53-55.

¹¹ Durham, op. cit., vol. i. p. 684.

in incarcerated criminals. The sane and unconfined suicide usually uses a razor or a knife; but the insane suicide and the prisoner, from whom cutting implements are withheld, often construct weapons out of spoons or forks, fragments of glass, or other available objects.

The individual who determines to commit suicide by cutting his throat, has usually become impressed with the erroneous popular belief in the necessary fatality of an extensive wound into the windpipe; while, the source of immediate danger to life really resides in division of the cervical blood-vessels, the elasticity and mobility of which often protect them from direct injury. As a rule, too, the head is bent backward, to render the windpipe more prominent as the stroke is made. Hence, the sterno-mastoid muscles are advanced, and the large bloodvessels are pushed behind the ordinary range of the knife, especially if the cut be made high up; and thus the main portion of the deep wound is in the air-passage. When, however, the suicide, like Lord Castlereagh, who thrust a penknife through his carotid artery, is familiar with the anatomy of his neck, or when in his excitement he makes a sweeping cut, the great cervical blood-vessels are severed in the incision, and death takes place by hemorrhage and not by reason of any opening that has been made into the air-passage. Sometimes, however, hemorrhage into the air-passage produces speedy death by suffocation. The infrequency of wounds of the great vessels is furthermore attributed to the resistance of the cartilages, which prevents deep incision at the level of the larynx; and to spasmodic contraction of the sterno-cleido-mastoid muscles when the cut is at a lower level (Durham); while when the trachea is severed, the sudden escape of air from the lungs is supposed to deprive the arm of the full support of the thoracic muscles, so that the arm falls before the stroke has been completed. (Hinton, cited by Durham.) The wound of the integument is usually from left to right, and more obliquely downward than transverse, the greater portion of the cut being upon the left side when the right hand has been used, as is the rule.

The size of the external wound varies from little more than a puncture to a length of several inches, even reaching from one sterno-cleido-mastoid muscle to the other. As a rule it is much larger than the wound in the air-passage, but sometimes it is much smaller, as in a case reported by Fine,¹ in which but a small external wound was made with the point of a penknife, while the thyroid cartilage was divided into eight portions.

Incised wounds of the neck, above the hyoid bone, do not implicate the larynx, although they may penetrate the air-tract by opening into the pharynx or into the mouth. Nevertheless, death by suffocation may ensue from occlusion of the larynx by the posterior portion of the divided tongue.²

The hyo-thyroid membrane is the most frequent seat of lesion. Wounds of this membrane, although, anatomically, wounds opening into the pharynx, must be discussed in connection with wounds of the larynx, because the epiglottis is frequently severed in the incision, sometimes in its free portion and sometimes at its attached portion. If not severed it is often wounded. In some instances the epiglottis escapes the cut, and the upper portion of the larynx is exposed to view uninjured. In a case of this kind, in an aged subject but recently (April, 1884) under observation in consultation with my colleague Dr. James Collins, at the German Hospital, Philadelphia, the section had divided the tongue, the sterno-cleido-mastoid muscles, both submaxillary glands, and the pharynx to within an inch of its entire circumference. In

¹ Jour. de Méd., Chir., Pharm., etc., 1790; quoted by Fischer (Pitha und Billroth's Handbuch, Bd. iii. 1 Abth. 3 Lief. S. 101).

² See Durham's case, Holmes's System of Surgery, vol. i. p. 687.

some instances the hyoid bone and the tongue are severed from the larynx; and the upper fragment of a still attached epiglottis may be seen in the upper segment of the wound, and its intra-thyroidal portion in the lower. The gaping in these wounds is very great. The extent to which the pharynx is severed may comprise its entire circumference, the knife penetrating a vertebra.¹ In a case seen by myself in the hospital practice of Dr. R. J. Levis, of Philadelphia, less than half an inch of the posterior pharyngeal wall had escaped division.

Cuts through the thyroid cartilage may wound the vocal bands. They seldom penetrate the entire cartilage. Sometimes they fail to reach the mucous membrane, so that the air-passages is not opened at all. Cuts through the crico-thyroid membrane may sever the larynx completely.² Cricoid cartilage³ and pharynx may be injured likewise. Sometimes one or both supra-arytenoid cartilages, or even the arytenoid cartilages, are severed or wounded. The crico-tracheal membrane is very rarely the seat of the wound. The resistance being slight, wounds here generally sever the trachea from the larynx.

That the larynx is wounded more frequently than the trachea, seems to be the individual opinion of surgeons as drawn from personal observations. Nevertheless, a systematic compilation by Sabatier⁴ gives the trachea as the seat of injury in 22 instances out of 45, or practically in one-half the cases, the crico-thyroid membrane having been severed in 13 and the thyroid cartilage in 10. Durham⁵ gives the trachea as the seat in 41 out of 158 unselected cases of penetration of the air-passages, the situation of the wound having been above the hyoid bone in 11 cases, through the hyo-thyroid membrane in 45, through the thyroid cartilage in 35, and through the crico-thyroid membrane in the remaining 26.

According to Malgaigne,⁶ the larynx is severed in young subjects only, and for the reason that they can throw their heads further back than old persons, in whom the suicidal injury is consequently more frequent in the trachea. If this be the rule, it is not without many exceptions; for wounds through the thyro-hyoid membrane at least are not uncommon in aged subjects.

When the epiglottis, or a portion of the arytenoid or supra-arytenoid cartilage, has been severed, there is liability to impaction of the fragment between the vocal bands or above them; an accident that may take place within a brief interval,⁷ or not until after some hours or a few days. Suffocation may ensue in such instances.⁸ Hence any movable fragment which might induce such an accident should be promptly excised, for it can rarely be safely secured for any length of time by stitching.

If the suicide has made several cuts in his neck, as shown by a jagged wound of the integument, portions of the cartilages may have been hacked into a number of pieces, some of which may hang loosely. Under such circumstances it becomes still more imperative to remove all fragments. The immediate danger of death by suffocation from hemorrhage into the air-passages, or from occlusion by blood-clots, is much greater in multiple wounds of this sort, than in wounds by a single stroke. The like danger is greater in wounds of the trachea than in wounds of the larynx, because of simultaneous severance of thyroidal vessels or of the thyroid body.

¹ Fischer, Pitha und Billroth's Handbuch. Bd. iii. 1 Abth. 3 Lief. S. 101.

² Hennen, Principles of Military Surgery, 3d ed. p. 368. London, 1829; Gross's System of Surgery, 6th ed. vol. ii. pp. 315 and 316. Philadelphia, 1883.

³ Stokes, quoted by Gross (op. cit., vol. ii. p. 315).

⁵ Holmes, op. cit., vol. i. p. 687.

⁴ Hortaloup, op. cit., p. 16.

⁶ Hortaloup, op. cit., p. 17.

⁷ Houston, Dublin Hospital Reports, vol. v. page 315; cited by Ryland, Durham, and others.

⁸ See cases narrated by Sir Chas. Bell (Surgical Observations, vol. i. p. 44). Dr. Wm. Stokes, and Prof. S. D. Gross (op. cit., vol. ii. p. 315).

Edema of the larynx sometimes follows incised wounds, especially those in which the upper portion of the larynx has been uncovered by division of the hyo-thyroid membrane. The action of the atmospheric pressure in rolling the œdematous aryteno-epiglottic folds inward and downward at each inspiration, is beautifully demonstrated in these instances, confirming Sestier's antelaryngoscopic theory of the mechanism in some cases of suffocation in œdema of the larynx.

Emphysema occurs in some cases of incised wound, especially when the wound in the integument does not open directly upon the wound in the air-passage. This emphysema may spread not only over the neck, face, and thorax, as is not infrequent, but likewise over the entire abdomen, down into the scrotum, or even into the mediastina or into the interior of the larynx.¹ It is most likely to occur in cases where the surgeon has been too assiduous in approximating the edges of the external wound.

Incised wounds of the trachea are due to causes similar to those of incised wounds of the larynx. They usually occupy the upper portion of the tube. They are often associated with wounds of the thyroid gland. They are liable to serious complication by suction in of the soft parts, so as to occlude the air-passage and threaten suffocation. Durham² refers to a fatal case of this kind related by Casper, and to a case narrated by Richet, in which the œsophagus projected forward and became interposed between the cut ends of the divided trachea.

The wound usually implicates the anterior or cartilaginous portion of the trachea only, and occupies one or more rings, passing obliquely from left to right. Sometimes the tube is divided in its entire extent, exposing the intact or wounded œsophagus, as may be; and then the lower end may become greatly retracted—so much so, if the wound be low down, as to become almost hidden at each inspiration. Durham³ cites a case from Richet,⁴ in which the trachea had been divided obliquely through four or five of its rings, the separation between the two portions measuring more than two inches, with an increase of about half an inch additional during inspiration, and the lower part plunging down almost into the mediastinum. The œsophagus is very liable to suffer injury in case of complete division of the trachea.

Hemorrhage is often quite copious from incised wounds of the trachea, especially if the thyroid veins or the thyroid gland have been wounded. The danger from entrance of the blood into the air-passage is greater than in similar wounds of the larynx. The laryngeal nerves are sometimes wounded (Larrey), but as a rule neither nerves nor great bloodvessels are injured, even though the sterno-mastoid be severed and the carotid artery exposed.

Emphysema occurs as in incised wounds of the larynx, and much more frequently because of the small size of the wound and the corresponding difficulty in the escape of the air.

Lacerated wounds of the larynx, other than gunshot, are very infrequent. They result from falls, kicks, blows from falling objects, and crushing violence by machinery and otherwise. They are almost always accidental. They are sometimes associated with wounds of the pharynx, as in the case of a fall on broken crockery, which recovered under the care of Mr. Bryant.⁵ Sometimes they are associated with comminuted fracture. They may be accompanied by laceration of the trachea, as in an injury from the kick of a horse, where a rupture extended through the thyroid and cricoid cartilages, and continuously through the first tracheal ring.⁶

¹ Horteloup, op. cit., pp. 53, 71; Durham, op. cit., vol. i. p. 688.

² Op. cit.

³ Op. cit.

⁴ Gaz. des Hôp. 1855, p. 35.

⁵ Brit. Med. Jour., Jan. 26, 1884, p. 164.

⁶ O'Brien, Edinb. Med. and Surg. Journ., vol. xviii.; quoted by Ryland and others.

Lacerated wounds are sometimes wholly internal, although caused by external violence.

Lacerated wounds of the trachea are more common than lacerated wounds of the larynx. They occur most frequently in the form of rupture between cartilage and ligament. Like lacerated wounds of the larynx, they are most frequently the result of various local injuries, such as falls, blows, kicks, and crushes. Counter-pressure may be an occasional cause, as in a case reported by Godlee,¹ in which the trachea of a child was split, front and back, immediately above the bifurcation, in consequence of the passage of a cart-wheel over the chest—the third, fourth, and fifth ribs sustaining fracture on the right side at their point of greatest convexity.

Causes of non-surgical origin occasionally produce rupture or laceration of the trachea, such as cough in croup² and bronchitis,³ chiefly in children; violent inspiratory efforts in dyspnoea from obstruction or compression;⁴ and violent expiratory efforts in parturition, or even in defecation. Rupture of the softened trachea may result from the pressure of an abscess, an aneurism, or a morbid growth.

In cases more strictly surgical in origin and character, the laceration or rupture may be associated with fracture of the cartilages. It often occurs independently.

The rupture occurs most frequently between two of the upper rings, or between the upper ring and the cricoid cartilage. In the latter case, the trachea may recede quite a distance from the larynx. An instance is recorded by Mr. Long,⁵ in which the trachea had become separated from the larynx for a distance of about two inches, as demonstrated during a tracheotomy which saved the life of the patient. The violence had been very great in this instance, the neck having been caught by the coupling-irons of two railway coaches. A case of complete rupture of the trachea from the larynx, the result of a kick from a horse, is recorded by Robertson.⁶

Gunshot wounds are most frequent in military practice. Nevertheless, their small proportion seems sometimes remarkable, the records of several extensive wars of the present generation not presenting a single example. The resiliency and mobility of the larynx and trachea doubtless deflect many balls, so that the air-tube, though struck, is not penetrated.⁷ The texture of the beard, and the position of the lower jaw, especially in the position of firing a gun, are regarded as additional factors in protection. The French contingent in the Crimean war⁸ reported but one wound of the larynx, and that a gunshot wound, out of a total of 28,401 wounds, of which 460 implicated the neck. The English contingent⁹ reported eight wounds of the larynx, pharynx, and œsophagus, out of 147 neck-wounds. Five of these cases, and an additional one, are related by Mr. Longmore in Holmes's System of Surgery. In Demme's Record of the Italian War of Independence, in 1859, there is no mention of wounds of the larynx, although there were 170 neck-wounds in the Austrian army, and 187 in the forces of the allies. Löffler's report of the Schleswig-Holstein war, in 1864, is said to be equally silent as regards

¹ Med. Times and Gaz., December 12, 1874, p. 675.

² Latour, Manuel sur le Croup. Orleans, 1808; Voss, New York Med. Jour., Jan. 1860, p. 37.

³ Bredschneider, Casper's Wochenschrift, S. 261. 1842; Lefferts, Medical Record, Nov. 25, 1882, p. 599.

⁴ Marshall, cited by Gross (op. cit., vol. ii. p. 317).

⁵ Brit. Med. Journ., July 26, 1856.

⁶ Lancet, September 6, 1856.

⁷ See case of Hooper, mentioned by Gross (System of Surgery, 6th ed. vol. ii. p. 315); and cases in the Medical and Surgical History of the War of the Rebellion, Part First, Surgical Volume, p. 405.

⁸ Chenu, cited by Witte (Arch. f. klin. Chir., Bd. xxi. S. 184. 1877).

⁹ Medical and Surgical History of the British Army, 1854-6, Witte, loc. cit.

the larynx, the number of neck-wounds being 48 out of 2355 among the Prussians, and 26 out of 1203 among the Danes. In the Austro-Prussian war of 1866, Biefel reports two wounds of the larynx and trachea out of 382 cases, and Maas reports one out of 212. As regards the last Franco-Prussian war, neither Bussenius nor MacCormac reports a single wound of the air-passage, but Beck reports nine cases out of 83 neck-wounds. Fischer reports three cases out of 15 neck-wounds, and Kirelmer reports one out of 32. Witte, from whom the above references have been culled, mentions other wars, the statistics from which are valueless in the present connection.

None of the statistics yet cited approach in completeness those given in Surgeon Otis's encyclopædic records of the War of the Rebellion.¹

Gunshot wounds of the larynx and trachea comprised 2.2 per cent. of the gunshot wounds of the neck that came under treatment during that war. In a few, the larynx and trachea were both involved; in others, the air-passages together with the pharynx or œsophagus. The trachea was less frequently injured by small projectiles than the larynx, and was most frequently wounded in its posterior, membranous portion. Ample evidence was afforded that missiles are diverted from their course on impact with the trachea. Out of 4895 cases of gunshot wound of the neck, without known injury to the cervical vertebrae, 41 involved the trachea, with 21 deaths, the result in one case being unknown; 30 involved the larynx, with 10 deaths, and 10 results unknown; 4 involved both trachea and larynx, with no death; 2 the trachea and pharynx, with no death; 2 the trachea and œsophagus, both fatal; 1 the larynx and œsophagus, the patient recovering; 2 the pharynx and larynx, both fatal.² Only four specimen-preparations are preserved in the U. S. Army Medical Museum—Nos. 648, 697, 1440, and 2021.

Gunshot wounds are mostly caused by bullets; some, by fragments of shell. They are usually complicated with contusion and laceration of the soft parts, and with comminuted fracture of the cartilages. Contusion, effusion, and suppuration of the interior may take place, although the ball does not penetrate the larynx.³ Fractures from gunshot wound have been recorded, without destructive wound of the integument.⁴

Whether the bullet shall pass through the larynx, as it does in some instances, or whether it shall remain impacted, as occasionally happens, depends upon the distance travelled by the missile, the tissues traversed before it impinges upon the larynx at all, the part struck, and the position of the individual and the part at the moment of injury; but Preparation 1440, U. S. Army Medical Museum, shows an imitation of the battered conoidal ball which lodged in the upper portion of the right wing of the thyroid cartilage, after having shattered the inferior maxilla to the right of the symphysis. The missile may lodge elsewhere in the tissues, after traversing the larynx. In a case reported⁵ by Dr. Daly, of Pittsburg, at the meeting of the American Laryngological Association in 1884, the bullet was removed from within the sheath of the sub-clavian artery on the side of exit. Large portions of the anterior portion of the larynx or trachea are occasionally destroyed in this manner. Dr. Chisolm⁶ mentions that several instances occurred among the Confederate forces, in the late war in the United States, where the larynx had been carried away. Sometimes the destruction is confined to the perforation made by the ball.

¹ Med. and Surg. History, etc., Part First, Surgical Volume, p. 406.

² Op. cit., Part Third, Surgical Volume, p. 688.

³ See cases recorded in Med. and Surg. History of the War of the Rebellion, Part First, Surgical Volume, p. 404.

⁴ Medical and Surgical History of the British Army, 1854-56, cited by Witte (loc. cit., S. 484); Wales, Am. Journ. Med. Sci., Jan. 1867, p. 269.

⁵ New York Med. Jour., July 12, 1884, p. 29.

⁶ Cited by Otis, Med. and Surg. History, etc.

Sometimes the epiglottis is carried away; sometimes it is split or simply wounded. The missile sometimes wounds the larynx after having passed through the face, the chest, or the upper extremity; and thus fractures of the jaw, clavicle, or humerus, and lacerations of the face, neck, and chest, become associated with gunshot wounds of the air-passages.¹

The hemorrhage in these cases is usually much less than in those of incised wound, but the syncope therefrom perhaps more frequent and more protracted.

The comparative infrequency with which the great cervical bloodvessels and nerves sustain injury, is attributed to their great mobility and elasticity. No mention of injury to the great bloodvessels or nerves is made in the description of any of the four specimens of gunshot wound of the larynx in the U. S. Army Medical Museum,² while the absence of such injury is alluded to in the description of two. (Specimens 648 and 1440.)

WOUNDS OF INTERNAL ORIGIN may be lacerated, contused, or punctured. They are usually produced by foreign bodies with hard, sharp, and jagged edges, such as coins, fish-hooks, needles, nails, splinters, fish and meat bones, and pieces of glass. These wound the epiglottis, or penetrate or tear the larynx or the trachea.³ They may excite inflammatory tumefaction with resultant œdema, or may irritate the nerve-tracts and excite spasm of the glottis, and may thus necessitate tracheotomy in either case.

Witte⁴ narrates a case, reported by Surgeon Cotting, in which a dart was inhaled into the larynx, point upward. The continuous efforts of the injured lad to cough the foreign body out, gradually drove the point of the nail through the thyroid cartilage into the sheath of the great bloodvessels, and death followed in consequence of a wound of the carotid artery.

Awkward and incautious attempts at intra-laryngeal surgery are responsible for a certain number of contused, lacerated, and even incised wounds. Hemorrhagic œdema may be instantaneous after contusions and lacerations. The wounds resulting from a proper use of the knife, forceps, or galvanocautery, are to be discussed in connection with the affections requiring such treatment.

Ziemssen⁵ relates a fatal case of œdema from spearing of the walls of the laryngeal ventricle by the rib of a tobacco leaf, and another sudden death from the same cause, after a wound produced by a pointed piece of bone. Cases of wound from foreign bodies are sometimes promptly fatal by suffocation.

In occasional instances, the injury has occurred by emesis during drunkenness, or in the course of cerebral disease, the soup or gruel vomited having contained hard substances which thus entered the air-passage.⁶ Beigel⁷ reports the case of a twenty-four year old female, with rupture of both vocal bands from their intersections at the arytenoid cartilages, and transverse rupture of the left band in addition, from continuous crying when a baby.

Inflammation follows the injury. (Edema may ensue, threatening suffocation, or spasm of the glottis with similar manifestations.

Symptoms of Laryngeal and Tracheal Wounds.—The symptoms of a wound of the larynx or trachea are usually sufficiently evident, save in some instances of contused wounds, in which the special manifestations do not promptly follow the receipt of the injury.

¹ For cases illustrating these points, see Catalogue U. S. Army Medical Museum, Surgical Section, p. 477. Washington, 1866. (Specimens 697, 1440, and 2021.)

² Op. cit.

³ See Foreign Bodies.

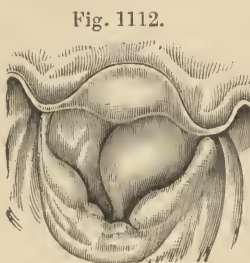
⁴ Arch. f. klin. Chir., S. 193. Berlin, 1877.

⁵ Cyclopædia of Practical Medicine, vol. xii. p. 80.

⁶ Witte, loc. cit.

⁷ Berlin. klin. Woch., 1868, S. 394; cited by Witte.

Contused Wounds give rise to one or more of the following group of symptoms: Bruise or other external evidence of injury; severe pain or tenderness on motion of the parts and on deglutition; dysphonia or aphonia; cough, with bloody expectoration; spasm of the glottis; spasmodic, opisthotonic retraction of the cervical muscles;¹ tumefaction of the integument. Dyspnoea is but slight, unless there has been tumefaction, effusion, or laceration and hemorrhage internally—circumstances under which apnoea may ensue. Insensibility from shock is noticed as a prominent symptom in some cases. Laryngoscopically, the evidence of congestion and of hemorrhagic effusion may be quite marked, as in a case reported by Dr. Packard,² of Philadelphia. (Fig. 1112.)



Laryngoscopic picture in contusion of the larynx. (Packard.)

Punctured wounds give rise to threatening apnoea from accumulation of blood in the air-passages. Punctured wounds of the trachea may give rise to hemorrhage internally, as shown by hæmoptysis, even though there be no hemorrhage externally. Emphysema of the neck is quite a prominent symptom, and may occasion serious dyspnoea. Sometimes it extends to a great distance from the seat of the external wound. In the efforts at expectorating, blood-clots may become lodged in the air-passage so as to occlude it. Such a clot has been known to become impacted in a ventricle, and to form there a valve preventing ingress of inspiratory currents of air. In either event, symptoms of suffocation will ensue. Pain or tenderness, cough, dyspnoea, and dysphonia or aphonia, exist in some instances as in wounds of the air-passages in general.

Incised wounds occasion various combinations of symptoms according to the extent of the wound, its location, the injury to the surrounding tissues, and the age and physical and mental condition of the individual. The main objective symptoms are: first, the gaping external wound, exposing the muscular and vascular tissues of the neck, the air-passage, and the pharynx or œsophagus, as may be; and, secondly, hemorrhage, and the escape of mucus, blood, and saliva, through the wound as well as from the mouth. Fluids swallowed will escape likewise in some instances, unless the parts are supported externally during deglutition. In a case of suicidal wound seen by myself, this was the first symptom to attract attention, hemorrhage having ceased, and the divided parts being concealed by a beard. Emphysema is usually a later manifestation than those detailed. The edges of the wound gape little or much, according to its location and the depth of the section. They are but slightly separated when the incision into the larynx or trachea has been shallow or incomplete, while they may be separated to a distance of several inches, even the breadth of a hand, when the section has been a deep or complete one. In wounds through the thyro-hyoid membrane, or the superior portion of the thyroid cartilage, the upper segment may recede to the very jaw. In wounds through the trachea, the lower segment may recede behind the sternum.

The hemorrhage is usually copious, even though the great cervical blood-vessels be uninjured. Dyspnoea or apnoea sometimes results at once, from entrance of blood into the air-passages; both much more frequently with small wounds than with large ones. The hemorrhage often ceases by syncope. Secondary hemorrhage, however, is to be expected on reaction, and this, again, may suffocate the patient, especially if the edges of the external wound have been stitched meanwhile in close apposition.

¹ Stromeyer, *Handbuch der Chirurgie*, Bd. ii. S. 309. Freiburg, 1865.

² *Archives of Laryngology*, vol. i. p. 57. 1881.

Suffocation is not imminent from hemorrhage alone ; but other causes may produce it, varying according to the location and character of the wound. Thus it may be due to occlusion of the larynx by the base of a divided tongue, or by a divided or detached epiglottis ; or to occlusion of some part of the air-tube by impacted fragments of severed or partially severed cartilage or other structure. Even the ball itself, in cases of gunshot wound, has been known to produce this symptom by its arrest in the air-passage. In case of threatening apnoea from loose fragments of cartilage, distinct flapping of the fragment may be recognized, as in the case under the care of Sir Charles Bell which has already been alluded to.

The subjective symptoms of incised wounds are pain, cough, spasm, dysphagia or aphagia, dyspnoea or threatening apnoea, dysphonia or aphonia.

Debility of voice sometimes results from direct injury to the vocal bands in wounds through the thyroid cartilage. In wounds above the vocal bands, the voice will be lost while the edges of the external wound are allowed to gape, and will be restored when they are approximated by bending the head, or when the external orifice is occluded with the hand or with a compress. Dysphagia and aphagia are usually due to section of the pharynx or oesophagus, food and drink escaping by the external wound, or passing into the air-passage. Cough is due to direct access of air, and access of mucus, blood, and saliva. Expectoration is usually difficult, and apnoea may result from this cause. Intense thirst is an occasional symptom, and may be very prominent, as in a suicidal case mentioned in the Medical and Surgical History of the Rebellion,¹ which required the use in a peculiar way of twenty gallons of water daily, to assuage it. Some water was sucked through a tube attached to a reservoir, and apparently swallowed ; and then a quantity was allowed to pass through the pharynx and escape by the wound.

Lacerated wounds present much the same symptoms as incised wounds. The hemorrhage is much less as a rule ; the danger from suffocation by blood or blood-clots, greater.

Gunshot wounds, complicated as they often are by serious contusion, may present the symptoms of contused wounds in addition to pain, emphysema, escape of fluids from the wound, aphonia or dysphonia, cough, expectoration, etc., as detailed in connection with the symptoms of incised wounds. The impact of the ball sometimes produces a local numbness, or a numbness extending into the arm, indicative of implication of the spinal accessory nerve. Torticollis is mentioned in military records as quite frequent. Contusion or laceration of the pneumogastric nerve or of its laryngeal twigs, may produce paralysis or spasm of the laryngeal muscles, entailing aphonia on the one hand or stridor on the other, from that cause, independently of any mechanical result of the direct lesion in the tissues. Stridor may be due, likewise, to paralysis of the dilating muscles of the glottis. Internal injury of the laryngeal structures is quite frequent, and aphonia may result from such direct injury to the vocal bands. Mr. Erichsen has called attention to a special loss of sensitiveness of the glottis, permitting the passage of food and drink into the air-passage, a condition recognized by S. D. Gross,² McGuire,³ and other writers, as a characteristic symptom of gunshot wounds of the larynx.

The primary hemorrhage is much less than in incised wounds ; but the secondary hemorrhage may be more profuse, and may suffocate the patient by inundating the air-passage or by occluding it with clots. Such accidents are particularly to be feared after too great assiduity in closing the external

¹ Op. cit., Part First, Surgical Volume, p. 409.

² Op. cit.

³ Holmes's System of Surgery, Am. Ed. vol. iii. p. 484.

wound. They are most to be apprehended after wounds of the trachea, in which injuries may have been sustained by the thyroïdal vessels and the thyroïd body.

The inflammatory swelling of the tissues during the process of repair may compress the air-passage externally, or encroach upon it internally, producing dyspnœa in either event.

Internal wounds of the larynx present no objective symptoms to direct inspection. Laryngoscopic exploration reveals the rent or other lesion in some instances, and fails to do so in others. The subjective symptoms are pain, cough, bloody expectoration, dyspnœa or threatening apnœa, dysphonia or aphonia, and dysphagia or aphagia.

Inflammation takes place in all wounds of the larynx or trachea. Sometimes restrained within beneficial limits, it may be excessive in debilitated, starved, or drunken subjects, and may readily become gangrenous.

Diagnosis.—The special diagnostic signs indicating the penetration of an external wound into the air-passages, are the presence of frothy blood at the seat of external injury, escape of air at the same point, or emphysema of the neck from escape of air into the cervical connective tissue, and escape of fluids through the wound on attempts to swallow them. To these may be added aphonia or dysphonia, aphagia or dysphagia, and dyspnœa or threatening apnœa.

Blood which has inundated the air-passage is expectorated in part by the mouth, and in part by the wound. Syncope is the usual result of severe hemorrhage, and in many cases the patients are found in that condition when seen immediately after the injury.

Prognosis.—Although recovery ensues in a large percentage of cases of wounds of the larynx and trachea, the prognosis is almost always to be regarded as doubtful. Wounds apparently insignificant terminate fatally in some instances; and recovery sometimes ensues in very severe cases, even when complicated by multiple section of cartilage, and by extensive injury to the pharynx, œsophagus, and other structures. Horteloup¹ records 67 recoveries out of 88 cases of large wound, and 10 recoveries out of 21 cases of small wound. Recovery is usually more protracted after punctured, lacerated, and gunshot wounds, than after contused and incised wounds.

Contusions of the larynx from blows may, according to Durham, prove suddenly fatal by shock, or by spasm of the glottis. Insensibility is said by the same writer to be a common effect, and one utilized by garroters to rob their victims. Hemorrhagic effusion into the connective tissue may produce suffocation.

Incised wounds of the trachea present a graver prognosis than those of the larynx. In either instance advanced age, insanity, and delirium tremens are additionally bad prognostics. Suicidal wounds, if not fatal within a few hours, may prove slowly fatal by exhaustion or otherwise, in from one to two weeks. Recovery from severe wounds rarely ensues earlier than in four or five weeks, and sometimes occupies a much longer period.

The prognosis is gravest as a rule in gunshot wounds, on account of the complicated nature of the injury in the first instance, which entails inflammatory tumefaction of the superjacent soft tissues, and on account of the greater danger from secondary hemorrhage. Contrariwise to what has been noticed of incised wounds, gunshot wounds of the larynx are much more fatal than those of the trachea. When both of these structures are involved, a fatal

¹ Op. cit., p. 86.

result would seem theoretically much more imminent, yet recovery ensued in the four such instances noted in the Medical and Surgical History of the War of the Rebellion. Simultaneous involvement of the pharynx and œsophagus does not seem to add much gravity to the case. Contusions or lacerations of the pneumogastric nerve or of its divisions render the prognosis more unfavorable, on account of the resultant paralysis of the dilator muscles of the glottis, or spasm of its constrictors, with consequent dyspnoea or even apnoea. At a later date, tumefaction of the integument and of the mucous membrane, and extravasations of blood beneath the mucous membrane or in the loose connective tissue, may again threaten death by apnoea.

In both incised and gunshot wounds, hemorrhage, venous or arterial, may be quickly fatal either by inducing exhaustion or by suffocation. As a rule, however, the bleeding soon ceases with syncope. A small amount of clotted blood in the trachea is sufficient to produce suffocation, if the patient is unable to eject it. Death, immediate or gradual, may ensue, too, from entrance of air into a vein,¹ an instance of which in a case of suicidal incised wound is alluded to by Stromeyer.²

After the immediate dangers have subsided, the result of suppuration may derange a favorable prognosis. Escape of mucus, pus, necrosed cartilage, food, or drink, into the air-passages, often occasions septic infection, usually manifested at first in broncho-pneumonia, and in rare instances proceeding to pulmonary gangrene. In this manner a cheerful prospect is often changed into a gloomy one. Circumscribed abscesses may form about the suppurating edges of the wounds, or diffuse ones may dissect the planes of connective tissue down into the mediastina, and thus excite pleuritis, or compression of the bloodvessels and phlebitis. In some instances, too, more especially in gunshot injuries, perichondritis and necrosis of the cartilage takes place, and renders the prognosis still more dubious.

Recovery takes place usually only after protracted treatment, in which weeks upon weeks may be occupied. Gaps in the cartilage become repaired with fibro-cellular tissue, the irregular and exposed edges having meanwhile become necrosed and exfoliated, and the uninjured portions ossified, as is usual in inflammatory affections generally. The tissue filling the gap gradually becomes fibro-cartilaginous, or actually cartilaginous. (Witte, Fischer.) In some instances a permanent fistula of the air-passage remains, often small, but sometimes quite large—after extensive injuries or great loss of substance—huge gaps exposing the epiglottis, the pharynx, and even the pharyngo-palatine folds. Albers, cited by Fischer,³ describes and illustrates one an inch broad and two inches long. In some instances, either fungous or cicatricial stenosis of the larynx or trachea takes place during recovery, or after it. In the one case, the excessive granulations, or the exuberant tissue, may be destroyed by cauterization, excision, or evulsion. In the other, the permanent use of the tracheotomy-tube is usually required. Attempts to excise or otherwise destroy the obstructive cicatricial tissue are rarely of service; while systematic dilatation is hardly more promising. Recontraction usually takes place on the suspension of the manipulations. A cicatricial membranous web sometimes forms across the larynx at the seat of the wound, a variety of stenosis said to be quite common.⁴ Similar stenosis of the trachea is a very rare sequel. (Witte.) Permanent thickening of the cartilages is likewise a frequent result. The dysphonia, or even the aphonia, which accompanies these injuries, is sometimes permanent. Diplophonia, or sudden change of

¹ Durham, *op. cit.*, vol. i. p. 687.

² *Op. cit.*, Bd. iii. 1 Abth. 3 Lief. S. 96.

³ Mackenzie, *op. cit.*, p. 409.

⁴ *Op. cit.*, Bd. ii. S. 310.

voice from shrill to deep, has been noted by Gibb,¹ after cicatrization of an incised wound of a vocal band.

Treatment.—The first indication is to avert impending suffocation; the next, to restrain hemorrhage.

Threatening apnœa, as intimated, may be due to nerve-lesions on the one hand—paralysis of the dilators of the glottis or spasm of its constrictors; or on the other hand to mechanical lesions—hemorrhagic or other effusion, œdema, or occlusion by detached portions of tissue. In either instance immediate tracheotomy is demanded, to be followed by the institution of artificial respiration if requisite. This preliminary tracheotomy is much more likely to be necessary in punctured, lacerated, and gunshot wounds, than in simple incised and contused wounds.

Treatment of Contused Wounds.—If respiration be impeded, laryngotomy should be promptly performed through the crico-thyroid membrane, and artificial respiration should be instituted through the opening. Respiration progressing satisfactorily, the next thing is to attend to any symptoms of collapse. This indication is best met by the injection of hot alcoholic fluids into the rectum, and subsequently into the stomach. It may be necessary to resort to hypodermic injections of stimulants, or even to intravenous injections of ammonia.

Treatment of Punctured, Incised, and Gunshot Wounds.—Impeded respiration having been relieved by withdrawal of blood and other liquids from the air-passages—by suction through a catheter, or by tracheotomy—and by removal of clots or detached tissues from occluding positions; hemorrhage having been restrained by ligature or compression; and collapse having been removed by stimulating injections into the rectum, or by hypodermic or intravenous injections, as may be—the next indication is to closely scrutinize the locality of the wound so as to recognize its entire bearings, as far as practicable, before tumefaction renders this impossible.

If the wound penetrate into the mouth, careful search should be made for clots in order to remove them. The tongue should be carefully examined to see whether it be intact. Should it have been severed, the posterior portion should be carefully secured by ligature, so that it may not fall back upon the orifice of the larynx. Any other wounds of the tongue, or any wounds of the palatine folds, should be secured with sutures.

If the wound pass through the hyo-thyroid membrane, or the upper portion of the thyroid cartilage, the condition of the epiglottis should be determined. Any detached pieces should be removed. Attempts at saving semi-severed portions by suture rarely succeed, and almost always entail inflammatory œdema of the epiglottis. If prophylactic tracheotomy have been performed below the injury, attempts to save semi-detached portions of the epiglottis by suture are justifiable; but under other conditions they may be imprudent. In all wounds, whether situated in this region of the air-passage or in any other, search must be made in the wound for any missing portions of cartilage or other tissue, that they may be promptly withdrawn.

If the trachea have been divided, a tracheotomy-tube should be adjusted to the lower segment. If merely punctured, or but slightly severed, the wound should be enlarged, and a tracheotomy tube inserted, unless the opening be so insignificant as to cause neither serious hemorrhage nor emphysema.

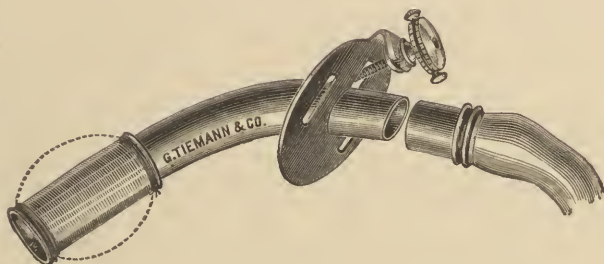
Inflammatory or infiltratory tumefaction, or any other sequel which produces sufficient encroachment on the calibre of the air-passage, will demand

¹ Fischer, op. cit., Bd. iii. 1 Abth. 3 Lief. S. 99.

tracheotomy at any stage of the treatment; a fact recognized and utilized in wounds both of the larynx and of the trachea by Habcot, as early as 1594.¹

Severe injuries to the larynx or trachea—whether fracture, laceration, or contusion—and the presence of foreign bodies in the air-tube, demand precautionary tracheotomy to insure the safety of the patient from the dangers of suffocation—dangers which cannot be ignored. The point at which tracheotomy is to be performed will have to be selected with reference to the individual case. This may be just below the cricoid cartilage, further down, or through the crico-thyroid membrane. The tampon-canula (Fig. 1113) is

Fig. 1113.



Trendelenburg's rubber-tampon canula; Gerster's modification. The dotted lines indicate the distension of the soft-rubber jacket when filled with air.

preferable in these cases to the naked instrument, as it occludes the entire calibre of the air-passage. In fact, it is questionable whether all wounds opening into the larynx through the thyro-hyoid membrane, or through the thyroid cartilage, should not be regarded as demanding precautionary tracheotomy. Although it is well known that extensive incised wounds do get well when left almost without surgical interference, it is equally well known that sudden suffocation sometimes takes place, despite every precaution save that of tracheotomy. This subject has been admirably discussed by Witte² in an article on wounds of the larynx and their treatment, especially in reference to the value of a prophylactic tracheotomy, the importance of which he has ably demonstrated. The precautionary tracheotomy does not add to the immediate risk in the slightest degree, and suppresses the risk in approximating the edges of the external wound, which is always run under other plans of treatment. Von Langenbeck³ counsels the performance of tracheotomy in all cases in which either phonation or respiration is seriously impeded.

The arrest of primary hemorrhage by syncope is apt to mislead the uncautioned practitioner, and tempt him to close the wound by suture—a procedure which prevents the escape of the blood at the second hemorrhage, which is almost certain to occur when reaction takes place. If the external wound be closed, this blood will run down the air-passage, and may drown the patient, or, clotting, may suffocate him. Cases made fatal by too assiduous attention of this kind are on record, and others are known by tradition and by observation. Liston was one of the most strenuous teachers of the impropriety of

¹ Sur la Bronchotomie. Questions Chirurgicales, chap. xv. pp. 77-83. Paris, 1620.

² Arch. f. klin. Chir., Bd. xxi. H. 1, 2, 3.

³ Militairärztliche Zeitschrift, Bd. i. S. 60; cited by Witte, loc. cit., S. 395.

such measures, and yet his own house-surgeon would have lost a patient in this way, had his master not instantly cut the sutures and removed a clot which impeded respiration.¹

It is important, therefore, in treating incised wounds that the parts should not be united by suture until there remains no further risk from reactionary hemorrhage. Arterial hemorrhage must be restrained by ligatures above and below the wound in the vessel, whenever practicable. But even ligature of the bleeding vessel does not secure immunity from the later hemorrhage, for this may be parenchymatous, or may proceed from vessels whose bleeding is not controlled by the ligatures. Should the hemorrhage be profuse, and beyond restraint by compression and by ligature of such vessels as are within reach, the indication would be to tie the carotid artery, a measure successfully employed under these circumstances by Le Gros Clark. When the external wound is very large, it is allowable to unite its outer portions; but the central part should be left open. Should bagging of the horizontal wound take place, the pockets should be divided vertically, as recommended by Stromeyer,² so as to prevent the burrowing of pus, which is otherwise almost certain, since union cannot take place by first intention, and extensive suppuration is to be expected. When all danger from hemorrhage has ceased, the tissues on either side of the opening into the air-passage may be brought together with adhesive strips, and a few sutures may be taken into the soft parts, ample room being left for drainage; but no suture should be taken through the cartilage or its perichondrium. Sutures are so illy-borne in these situations, and so pulled on in coughing, that they either cut out and are useless, or excite such an amount of local irritation as to necessitate their withdrawal. Although Prof. Gross and other surgeons express themselves free from fear of this kind, a careful perusal of published records shows that those cases have done best in which these sutures have not been used; and that in most instances in which they have been employed, they have torn their way out, or have had to be removed, even in cases where the wound was not extensive. Sutures are rarely necessary even in the soft parts. They will tear out from the pharynx; while extensive wounds, comprising almost the entire circumference, will, when let alone, sometimes heal up with a very small cicatrix. Should the external wound be drawn together too much, emphysema may take place by interference with the full escape of the expiratory currents of the breath.

The parts having been placed in apposition as far as may be judicious, and the patient placed in the semi-recumbent position, the head is to be flexed and to be retained in position by a cap or handkerchief-bandage (Mayor's occipito-sternal cravat) attached to a chest bandage beneath the arms, or to the waist-band of a pair of drawers, or to the foot of the bed—the object being to maintain the horizontal edges of the wounds in juxtaposition, and thus to favor cicatrization, which may be expected in from two to three weeks. The head should not be drawn so far forward as to make the edges of the wound overlap. Prof. Stromeyer attaches a small tuft of hair sidewise over the brow to a bandage fastened to a girdle or jacket, to act as a reminder to the patient to avoid incautious movements. He mentions the case of a man in whom the sterno-mastoid muscle had been cut through; and although the head stood straight when no movement was made, it flapped toward the opposite side on the slightest movement, as quickly as the snap-to of the blade of a pocket knife; an action which ceased as soon as the head was bound by a tuft of hair to the opposite side.

The dressing should be completed by covering the wound lightly with a

¹ Practical Surgery, 2d ed., p. 364. London, 1838.

² Op. cit., S. 32.

piece of gauze, or a woven scarf, to raise the temperature of the inspired air and prevent the access of flies. This dressing may be carbolized. The apartment should be kept at a warm temperature, and the atmosphere moist, just as after ordinary tracheotomy. Insane patients and determined suicides require close watching, to see that the dressings remain undisturbed.

The inflammatory action following the injury is to be treated on ordinary antiphlogistic principles, locally and constitutionally; by rest, cold, anodyne fomentations, and leeches, if necessary, and by febrifuge and anodyne mixtures.

If œdema of the larynx or other obstruction to respiration occur at the seat of injury, the trachea should be opened at a lower point, and a tube introduced. A precautionary, prophylactic tracheotomy will have anticipated this contingency.

Emphysema of the neck may require punctures or incisions through the integument; but if the edges of the wound be not yet adherent, the air can often be expelled by systematic manipulation towards the orifice. Should this be unsuccessful, the external wound should be enlarged, and the process repeated. Low tracheotomy is sometimes required under similar conditions to prevent suffocation; and quite a long tube, or a section of rubber tubing, may be necessary for a few days to insure access of air into the trachea. Exuberant granulations should be cauterized with solid nitrate of silver. Cough is to be repressed by anodynes.

Nourishment can be given by the mouth if there be no wound of the pharynx or œsophagus, and can usually be well taken even though the epiglottis have been severed. If those structures have been wounded, it is best to insert a soft rubber catheter through the larger nasal passage into the œsophagus, where it may be maintained undisturbed for several days. Most surgeons prefer that the tube should be inserted through the mouth. Liquid nourishment can be passed through the catheter at stated periods by means of a syphon-tube or funnel, the external orifice being, in the intervals, secured by a ligature. Food may likewise be administered by enema; and medicine, if necessary, by either method, or by hypodermic injection.

Antiseptic sprays allowed to play upon the wound at stated intervals tend to keep the granulations clean and healthy. The secretions escaping from the wound should be caught upon a disinfected sponge or mop as fast as they are expelled, to prevent them from being sucked back by the inspiratory current.

The administration of opium is indicated to restrain hypersecretion and to repress cough, but caution is requisite to avoid obtunding sensibility to such an extent as to favor the passage of fluids into the air-tube.

Should the wound fail to unite in its entire extent, the fistulous opening which remains can sometimes be closed by systematic cauterization, nitric acid and nitrate of mercury being the most efficient agents. In case of failure by this plan, a plastic operation may succeed. Transplantation of cartilage from the ear of the rabbit might be tried under these circumstances.

A pad, secured by a bandage, is sometimes worn over the opening, so that voice and articulation can be rendered effective.

Stenotic constrictions can sometimes be overcome by systematic dilatation. Successes have been reported by Liston and others. In many instances, perhaps in most, a tracheotomy tube becomes a permanent necessity. It is sometimes practicable to overcome the stenosis by dilatation years after immediate treatment has been discontinued. In a case placed under my care by Prof. Joseph Pancoast, of Philadelphia, in 1866, this was satisfactorily accomplished by the frequent passage of large, perforated, hard catheters

through the wound, which was just below the vocal bands, up into the mouth, and by see-sawing them forcibly for a few moments at a time.

In a case of extensive adhesion of the vocal bands in a case of cut-throat, Dr. Eysell, of Halle, succeeded in effecting the division with a narrow tenotome passed through the cicatrix.¹

Treatment of Wounds of Internal Origin.—If respiration be very much impeded, prophylactic tracheotomy is indicated in this class of wounds, as in those of external origin, and for like reasons. Foreign bodies must be removed; whether by the aid of laryngoscopic manipulation, or by gaining direct access externally, will depend upon conditions which will be discussed hereafter. If there be great tendency to hemorrhage, the tampon-canula instead of the naked instrument, should be inserted into the tracheotomy wound. Locally, cold externally, ice-pellets in the mouth, and sedative inhalations in spray, are indicated to repress inflammation and allay pain. Topical applications of solutions of morphia or of aconite are useful when the pain is severe.

II. BURNS AND SCALDS OF THE LARYNX AND TRACHEA.

Burns and scalds of the larynx and trachea are usually associated with similar injuries to the mouth, tongue, palate, nasal passages, pharynx, or œsophagus.

Burns are most frequently produced by the inhalation of flame, hot steam, or the heated air and smoke of burning houses or ships. They are often associated with burns of the head, neck, arms, and chest, and sometimes with burns over large portions of the body. *Scalds* are usually due to the voluntary or involuntary deglutition of hot and caustic fluids. Some scalds from caustic substances in adults are suicidal. Scalds were formerly quite prevalent in England among the children of the poor, who, having been accustomed to drink cold water from the spout of a tea-kettle, endeavored to quench their thirst while the vessel contained boiling water.²

When flame or hot air is inhaled, and when hot or caustic fluid is swallowed unknowingly, the larynx is much more likely to be involved than when the drink is taken designedly. In the latter case, the epiglottis protects the larynx as usual from ingress of fluid, and the injury is sustained chiefly in the mouth, pharynx, and œsophagus—sometimes even in the stomach—the act of deglutition having been completed despite any pain or spasm. In unwitting deglutition, however, the epiglottis is surprised, as it were, and fails to occlude the larynx efficiently, so that that organ sustains the brunt of the injury. It is contended, too, that an involuntary inspiration draws the caustic fluid into the larynx. Spasm of the glottis takes place, as a rule, protecting the subglottic portion of the larynx; for the portion below the vocal bands is often found normal in post-mortem examination after these accidents,³ the injury having been confined to the upper part. Swallowing is rarely completed under the circumstances just indicated, and regurgitation takes place in part through the nasal passages, thus injuring the mucous membrane of that region and of the adjoining retro-nasal portion of the pharynx.

In support of the statement that hot and caustic fluids taken accidentally are rarely swallowed, it may be mentioned that, on consulting the records of

¹ Med. Times and Gaz., October 17, 1874; Am. Journ. Med. Sci., January, 1875, p. 275.

² Marshall Hall, Med.-Chir. Trans., vol. xii. London, 1822; and others.

³ For recent examples, see Davies-Colley, Med. Times and Gaz., February 18, 1882.

numbers of cases in which boiling water has been taken into the mouth, and in which death has ensued from the resulting laryngitis, no evidence has been found of the fluid having reached the stomach in any instance, and in but few cases had it reached even the upper portion of the œsophagus. I have seen no record of deglutition of boiling water for suicidal purposes; but it is fair to infer that a case of the kind would furnish evidence that the fluid had reached the stomach, just as acid and caustic solutions do in suicidal cases.

Acute laryngitis, *laryngitis combustionis*, rapidly supervenes upon burns and scalds of the larynx, often immediately. It is often intense, and is generally attended with extensive œdema. It is not limited to the mucous membrane, but engages the submucous tissues likewise. The inflammatory process is usually confined to the supra-glottic portion of the larynx; but in some instances it extends to the trachea and the bronchi, and even to the lungs. Pneumonia and broncho-pneumonia may supervene without direct implication of the trachea and the larger bronchi. In some instances the inflammation does not overstep the pharyngeal surface of the larynx. In others a plastic, exudatory slough, similar to the plastic exudation of croup—showing arrested circulation from the violence of the inflammation, and consequent necrosis of the mucous membrane, *coagulation necrosis* (Weigert)—is produced along the entire tract of injury and beyond it. It has been found after death in the larynx, trachea, and bronchi.

Symptoms.—The immediate symptoms are pain, dyspnœa, dysphagia, dysphonia or aphonia, shock, accelerated pulse and respiration; and, at a later period, inspiratory stridor, spasm, threatening suffocative apnœa, and collapse. In cases of burns from the heated air and smoke of burning buildings, the sputa may contain black, carbonaceous material.¹ Œdema of the epiglottis or of the aryteno-epiglottic folds may be almost immediate, or may be developed during the course of a few hours. In cases associated with burns of the trunk and limbs, rather than of the head and neck, it may not occur within a week.

The symptoms do not always appear at once. Thus, Porter² says that he knew a girl, after swallowing a dose of sulphuric acid, to sit quietly and drink tea with some companions, who were afterwards suspected of having poisoned her, although the dose had been so powerful that she died in a few hours. He likewise knew of a man who took a second drink of the sulphuric acid, because he thought that the first dose was not sufficiently quick in dispatching him.

Diagnosis.—Except when the nature of the accident is purposely concealed by a determined suicide, the diagnosis is easy, especially in adults. Severe pain in the part, dyspnœa, dysphagia or aphagia, acceleration of the pulse and respiration, and the history of the case, are usually sufficient to establish the fact of a burn or scald. The interior of the mouth, the posterior portion of the tongue, the palate and pharynx, if seen early, are inflamed, swollen, and vesicated or blistered, or are covered with white patches, as though cauterized—often from detachment of a slough of epithelium—while the mucous membrane is seen to have undergone destruction in spots. In some instances, the œdematous epiglottis can be seen erect on ordinary inspection.³

There are few records of laryngoscopic examination of the parts injured. Tuerek⁴ has depicted the laryngoscopic appearance of a circumscribed, symmetrical cauterization of the outer, inferior surfaces of the arytenoid car-

¹ Cohen, *Inhalation: its Therapeutics and Practice*, p. 294. Philadelphia, 1869.

² *On the Larynx and Trachea*, p. 178. London, 1837.

³ Mackenzie, *op. cit.*, p. 281.

⁴ *Klinik der Krankheiten des Kehlkopfes und der Luftröhre*, S. 182. Wien, 1866.

tilages, from deglutition of dilute nitric acid. In a case examined by myself, there was œdema of the aryteno-epiglottic folds, in a case of burn of the larynx, the result of inhalation of flame in a burning building.

Prognosis.—The prognosis is always grave when the injury has been extensive, recovery being rare in severe cases. In slight cases the patients may recover thoroughly in a few days, but in severe cases they may perish at once, or within from twenty-four to forty-eight hours. The suppuration is profuse and exhausting. Sloughing of the arytenoid cartilages has been observed. (Ryland.) When recovery does ensue, it is often with permanent stenosis of the larynx, cicatricial and infiltratory, requiring the use of the canula for respiration through an artificial opening.

Death may take place by shock or by suffocative apnea, or at a remoter period by laryngitis, bronchitis, or pneumonia. Even though immediate death by threatening suffocation be averted by tracheotomy,² statistics show that more than half of the patients operated upon perish.

Treatment.—It is very rarely that a patient is seen soon enough after swallowing an acid or caustic alkali, to expect advantage from administering neutralizing agents, whether by deglutition or by the stomach tube. In severe cases of burn or scald of the larynx, precautionary tracheotomy seems to be demanded, as the laryngitis excited is apt to be attended with œdema of the larynx, which may prove fatal by suffocation before surgical relief can be given. Most surgeons, however, prefer to await the onset of the threatening symptoms, this delay, perhaps, accounting in part for the slight amount of success which follows tracheotomy in these cases. Durham³ reports that of 28 cases of tracheotomy in scald of the larynx, of which he had notes, 23 terminated fatally. If tracheotomy be deemed unnecessary, puncture or scarification of the œdematous mucous membrane may be employed with great advantage, and in some instances may obviate the necessity for the graver operation.

As the inflammatory process rarely extends below the glottis, owing to spasmodic closure of the vocal bands at the time of the injury, the larynx may be opened through the crico-thyroid membrane in these cases; especially in the adult, in whom the opening will be large enough to admit a sufficiently capacious tube. The operation is much less successful in children than in adults; the hemorrhage being more profuse, and the debility greater from the loss of blood.

Slight cases may be treated efficiently by rest in the recumbent position, cold compresses or ice externally, and anodyne inhalations in vapor or in spray. Mucilaginous drinks are soothing to the parts, and contribute somewhat to nourishment. Anodynes may be combined with them. Sprays of acetate of lead and of carbonate of sodium sometimes afford great relief.

Severe cases require active antiphlogistic treatment, locally and constitutionally. Collapse having been counteracted in the first instance by stimulant enemata, blood may be drawn by leeches from the upper portion of the sternum, and the same part may then be covered with warm, sedative fomentations, while ice-bags, iced-water tubes, or cold compresses may be applied over the larynx as in milder cases. If the patient can swallow, an emetic should be given by the mouth; if not, emesis may be excited by apomorphia hypodermically. Mild chloride of mercury in doses of one, two, or three grains, every half hour, hour, or two hours, until free bilious evacuations ensue, has

¹ Inhalation, its Therapeutics and Practice, p. 294. Philadelphia, 1867.

² Kuehn, Die künstliche Eröffnung der Luftwege, S. 278. 1864; Gurli, Arch. f. klin. Chir., Bd. i., S. 172, 194; Bryant, Surgical Diseases of Children, p. 67. London, 1863; Durham, op. cit., vol. i. p. 701.

³ Op. cit., vol. i. p. 701.

been highly recommended.¹ Mercurial inunction may be substituted, if swallowing be impracticable, and may hasten the specific action of the drug when calomel is given internally. Durham² reports the best results in burns from the administration of preparations of antimony and aconite, in small doses frequently repeated; the intervals being but fifteen minutes for the first hour or so, and being then lengthened according to the effects produced. Anodynes may be given by the mouth or hypodermically, as indicated. Pellets of ice in the mouth, *ad libitum*, add much to the comfort of the patient, and tend to repress inflammation. Milk may be given as nourishment in most instances. If dysphagia prevent deglutition, the rectum must be depended on for the introduction of nourishment.

ŒDEMA OF THE LARYNX.

Œdema of the larynx, long incorrectly called œdema of the glottis, for the rima glottidis is rarely involved, is an infiltration of fluid or semi-fluid products into the submucous connective tissue of the upper or of the inner surface of the larynx, or of either surface of the epiglottis. It is rarely an œdema in the strict sense of the word—a hydrops, that is to say, or a passive accumulation of serum—but it is rather an œdematous infiltration accompanying an inflammatory process by which it has been occasioned, whatever may have been the origin of the inflammation. Thus, the infiltration may be serous, lymphous, sero-sanguinolent, sanguinolent, sero-purulent, or purulent. The serous effusion occurs in cases marked by great rapidity of morbid action, and the purulent in cases of slower and less violent inflammation. Hemorrhagic effusions are sometimes instantaneous, as in contused and other wounds. Lymphous effusions are usually gradual. The œdema may be acute or may be chronic. Sometimes the process is idiopathic, sometimes traumatic, and often deuteropathic. However occasioned, the effusion diminishes the space for breathing, so that the process of respiration becomes first impeded and then obstructed; and if subsidence of the effusion does not take place spontaneously, or by prompt surgical interference, rapid apnoea by suffocation may ensue, or slow apnoea by congestion of the brain or lungs, death taking place within a few hours or a few days as may be.

The pathology of acute œdema of the larynx was not understood before the present century; and many cases, among them, most probably, the fatal cases of General Washington and of the Empress Josephine, were looked upon as cases of croup, the subjective symptoms of which are closely similar. But in 1808, a remarkable paper by Bayle³ was presented to the Society of the Parisian School of Medicine, fully discriminating the malady from all others, and this led the way to its thorough recognition, and to its prompt and intelligent treatment. Impediment to free circulation in the venules of the laryngeal mucous membrane, whether from inflammatory process, mechanical obstruction, or paralysis of vessels, is the immediate physical cause of the effusion as in the case of many other serous accumulations—the remoter cause being idiopathic or deuteropathic inflammation, or mechanical or surgical injury.

Mechanical impediment to respiration by the tumefaction of the tissues hardly represents the entire pathology of the dyspnoea in laryngeal œdema.

¹ Wallace, *Lancet*, 1833, vol. i. p. 657; Bevan, *Dub. Quart. Journ. of Med. Science*, Feb. 1860; Sloane, *Brit. Med. Journ.*, Jan. 14, 1866; Croly, *ibid.*, June 16, 1866; and others.

² *Op. cit.*, vol. i. p. 700.

³ *Mémoire sur l'œdème de la glotte ou angine laryngée œdémateuse.*

Spasm of the muscles closing the glottis (lateral crico-arytenoids and central arytenoid), or paralysis of the muscles opening it (posterior crico-arytenoids), probably exists in many instances. Otherwise it is impossible to account for the fatal issue, even allowing that the œdema subsides after death. As elsewhere mentioned,¹ the encroachment upon the breathing space has been seen laryngoscopically to be much less in some instances than would be credited without inspection, although the swollen tissues cast such shadows upon the glottis as to render it impossible to pronounce as to its patency. These views have received additional support from recent observations² of actual obstruction of the glottis by paralysis or spasm.

ACUTE ŒDEMA OF THE LARYNX from acute laryngitis usually occupies the two aryteno-epiglottic folds, although instances occur in which but one is involved. The epiglottis may be involved likewise, or it may be the sole location of the effusion. The ventricular bands, the inter-arytenoid folds and the inner aspect of the arytenoid cartilage, are much less frequent seats of the process; and the vocal bands, with their intrinsic thyro-arytenoid muscles, are the least frequent seat. Occasionally the process is wholly subglottic. Œdema of the tracheal submucous tissue occasionally occurs, six instances of this condition having been collated by Sestier³ out of a total of one hundred and thirty two of œdema of the larynx. Infiltration into the base of the tongue and into the pharynx is a more frequent complication.

CHRONIC ŒDEMA OF THE LARYNX occurs as an epiphenomenon in the chronic laryngitis of tuberculosis and syphilis, both ulcerative and non-ulcerative; in laryngeal perichondritis and chondritis of whatever origin; in the irritative laryngitis due to morbid growths; in carcinoma of the larynx or pharynx; in glossitis; in the pharyngitis consecutive to tonsillitis and to malignant disease of the tongue, palate, pharynx, and œsophagus, whether implicating the larynx directly or not; in glandular and other cervical and mediastinal tumors; in thoracic and abdominal aortic aneurisms; and in fractures, wounds, and other injuries of the larynx, adjacent soft tissues, or great cervical bloodvessels. Under these circumstances the affection becomes for the time more important than the disease which has occasioned it.

It comes on gradually, rarely without prodromic manifestations, and may continue for weeks and months before it excites a suffocative paroxysm, even though it present great occlusion of the orifice of the larynx. This occlusion occurs so gradually that the system becomes accustomed to it; for the same amount of œdema in an acute case would be almost certain to produce intense dyspnoea, suffocative paroxysms, and passive pulmonary congestion.

Chronic œdema is more frequently unilateral than acute œdema, the diseases of the larynx which produce it being themselves often unilateral.

SUBGLOTTIC ŒDEMA OF THE LARYNX is not frequent. The closeness with which the mucous membrane hugs the perichondrium below the vocal bands does not favor accumulations of fluid in that region. Still, there is some loose connective tissue in the lateral regions of the cricoid cartilage, where such accumulations can take place. The effusion is usually fibrinous; rarely serous. It is usually independent of any effusion in the upper portions of the larynx; but the two conditions have been known to coexist.⁴

¹ Diseases of the Throat, etc., 2d ed., p. 443. New York, 1879.

² Gougenheim: *Annales des Maladies du Larynx*, etc., Juillet, 1883, p. 125.

³ *Traité de l'angine laryngée œdémateuse*. Paris, 1852.

⁴ See Specimen in St. George's Hospital Museum, London, described by Gibb (op. cit., p. 218).

Etiology.—Very rarely, indeed, is acute œdema of the larynx a primary, idiopathic affection. Sestier¹ noted 36 cases out of 190. It has been known, however, to follow so closely upon exposure to cold and rain, deglutition of very cold drinks,² and prolonged vocal effort, as to seem primary; but acute or subacute inflammatory laryngitis may have preceded. It may follow traumatism quite as promptly, for Ziemssen³ has reported a case, in a man who was smoking, of death within a few minutes after penetration of the wall of the laryngeal ventricle by a piece of rib of tobacco-leaf. It often occurs in the traumatic laryngitis from deglutition of hot and caustic solutions, from burns, or from the presence of foreign bodies. It is quite frequent in wounds of the larynx. It may occur in gunshot wounds of the neck, even when the larynx is not implicated. Thus, fatal œdema is reported on the fourth day after such a wound from a 1½ inch grape-shot, which entered near the right horn of the hyoid bone, passed obliquely across the neck, and lodged in the subscapular fossa, whence it was removed by incision.⁴ It sometimes occurs in sore throat. Roger⁵ relates an instance of sudden death in a slight case of sore throat in a hospital servant. Trousseau mentions a case saved by tracheotomy, in which it occurred from sleeping in the open air after an evening's debauch;⁶ and Laveran, a case fatal within fifteen minutes, in a soldier, a day after suspension of treatment for sore throat.⁷ Simple inflammation was regarded as the cause in more than six per cent. of Sestier's cases. In such instances, Mackenzie⁸ believes the œdema to be nearly always due to blood-poisoning.

(Edema of the larynx has been noted in aneurism,⁹ obstruction of the hepatic duct,¹⁰ erysipelas,¹¹ ecthyma,¹² scarlatina,¹³ measles,¹⁴ smallpox, facial erysipelas (by myself), typhus and enteric fever,¹⁵ glanders, nephritis,¹⁶ whooping cough,¹⁷ capillary bronchitis, pneumonia, croup, diphtheria, and anasarca.¹⁸ It is chiefly in the waning stages of these affections, or during convalescence therefrom, that the œdema takes place, probably in consequence of lack of protection from drafts of air. It is a rare accompaniment of general anasarca, probably because there is no sore throat or laryngitis to start it.¹⁹ It occurs occasionally in acute iodism²⁰ and in mercurialization. It is therefore prudent to supervise patients with laryngeal disease to whom, for the first time, mercury and iodine are being administered in decided doses. Phlegmonous glossitis, and diffuse inflammation of the connective tissue of the neck, sometimes give rise to œdema of the larynx, by contiguity.

Mackenzie²¹ attributes œdema of the larynx largely to septicæmia, having met with the affection in hospital physicians, medical students, and nurses.

¹ Op. cit.

² Albers, cited in my work already quoted (*Diseases of the Throat, etc.*, p. 477).

³ *Cyclopedia of Practical Medicine*, vol. vii. p. 794.

⁴ *Med. and Surg. History of the Rebellion, Part First, Surgical Volume*, p. 404.

⁵ *Dict. de Méd.*, t. xxii. p. 575.

⁶ *Clin. Méd.*, t. i. p. 651. Paris, 1877.

⁷ *Gaz. des Hôp.*, 20 Juin, 1876, p. 565.

⁸ Op. cit., p. 274.

⁹ Moore, *Dub. Quar. Jour. Med. Science*, August, 1869, p. 13.

¹⁰ Farre, *Lancet*, April 21, 1860, p. 393.

¹¹ Gibb, *Diseases of the Throat*, p. 218. London, 1864.

¹² Boeckel, *Annales des maladies de l'oreille, du larynx, etc.*, tome i. p. 387.

¹³ Barry, *Central Zeitung für Kinderheilkunde*, No. 19. 1879.

¹⁴ Ryland, op. cit., Case IV.; Pilcher, *An Epidemic of Measles*, p. 5. 1876.

¹⁵ Emnet, *Amer. Jour. Med. Sciences*, July, 1856; Merklein, *La France Méd.*, No. 69, 1883.

¹⁶ Fauvel, *Aphonie Albuminurique*. Rouen, 1863. (He has shown it to be sometimes the first symptom.); Thompson, *St. George's Hosp. Rep.*, vol. iii. p. 302. 1868; Hayden, *Brit. Med. Jour.*, April 11, 1874, p. 489; myself, and others.

¹⁷ Barthez, *Gaz. des Hôp.*, No. 32, 18 Mars, 1869, p. 121.

¹⁸ Billard, *Traité des maladies des enfans nouveau-nés à la mamelle*, p. 491. Paris, 1828.

¹⁹ Sestier, Mackenzie.

²⁰ Nélaton, *Abeille Méd.*, t. x. p. 217; Laurie, cited by Stillé (*Therapeutics*, 3d ed., vol. ii. p. 763); Fenwick, *Lancet*, Nov. 13, 1875, p. 698; Cohen, *Diseases of the Throat, etc.*, p. 446, note.

²¹ Op. cit., p. 274.

and in cases where defective drainage seemed to be its cause. He adds that in every case that has come under his notice, ample opportunity of acquiring septicæmia has been present. Exposure to cold and moisture appears to be the usual exciting cause, in idiopathic and deuteropathic œdema, whatever the predisposing cause. Acute œdema from disease is exceedingly infrequent in childhood. Out of a total of 245 cases, Sestier¹ reports five under five years of age, one being in a new-born infant, and twelve cases between five and fifteen years. It is much more frequent in men than in women; simply, probably, because of their greater exposure to atmospheric changes. Of 187 cases in adults, in Sestier's lists, but 56 occurred in women. It is more frequent in intemperate individuals than in the temperate. Predisposition seems to exist in some individuals, for cases of recurrence have been recorded.²

Edema occurs traumatically from severe intra-laryngeal or perilaryngeal cauterization, and from attempts at removing morbid growths—the epiglottis and aryteno-epiglottic fold, or a supra-arytenoid cartilage, being seized and contused between the blades of forceps.

Symptoms.—Acute œdema of the larynx occurs so suddenly at times that the subject perishes without any premonitory symptoms whatever. Van Swieten³ mentions a death with sudden change of voice, while dining. Morgagni⁴ mentions a similar case, in a physician, who suddenly became hoarse, and died at once. Porter⁵ knew of two young men found dead from œdema in the morning, without any complaint having been made by them the night previous. Ruehle⁶ mentions a young man with swollen tonsils and overheated by dancing, found dead in the morning from œdema which had suffocated him without awakening him; and likewise the case of a servant girl, slightly hoarse, who went out lightly clad in the morning, and was suffocated while going up stairs on her return.

Sometimes the manifestations are so sudden and intractable that even in a hospital the patient perishes before aid can reach him. Roger,⁷ while an *interne* at Hôtel-Dieu, was summoned to an attendant in an adjoining ward, who died of sudden suffocation before he could be reached; and yet there had been no complaint save of a sore throat, so slight as not to interrupt the man's work in the hospital.

These instances of sudden death certainly seem to indicate a sudden occlusion of the glottis from spasm of its constrictors, or from paralysis of its dilators, rather than a mechanical death from serous effusion. It is quite probable that the œdematous condition may have existed for some hours or days undetected and unsuspected, and that some sudden inspiration of dust, or of saliva, has produced an immediately fatal spasm.

Deuteropathic œdema of the larynx may be preceded by pyrexia. In some instances discomfort in the larynx, and a disposition to cough, may exist for two or three days. Much more frequently the symptoms are sudden, marked, and rapidly progressive in severity. They are local tenderness—sometimes amounting to intense pain in acute cases—with hot and dry throat, and a sense of constriction or obstruction within it. Inspiratory stridor now ensues, sometimes sonorous or sibilant, and this rapidly increases until suffocative apnœa seems impending. Cough occurs in the form of voluntary efforts

¹ Op. cit.

² See particularly case of Roberts, *infra*.

³ Cited by Ruehle, *Die Kehlkopf-Krankheiten*, S. 158. Berlin, 1861.

⁴ De Sed. et Caus. Morborum, Epist. xxii.; cited by Bayle.

⁵ Surgical Pathology of Larynx and Trachea, p. 82. London, 1837.

⁶ Cited in my work already quoted, p. 447.

⁷ Dict. de Méd., t. xvii. p. 575.

to rid the throat of the obstruction within; and saliva and mucus are sometimes expectorated. The voice gets feeble, then indistinct, and finally extinct in some instances. Dysphagia exists in consequence of the swollen epiglottis or margin of the larynx, and sometimes amounts to aphagia. Forced deglutition has sometimes proved immediately fatal. Restlessness soon ensues. Sleep may be impossible from fear of suffocation, or occasional slumbers are soon broken by suffocative paroxysms. These often subside quickly at first, leaving intervals of absolutely unimpeded respiration—further evidence in favor of the nervous origin of the dyspnoea and the stridor. The obstruction to breathing is at first confined to the inspiratory phase of the act, and is generally attributed to occlusion of the entrance of the larynx, by contact of the tumid folds of tissue approximated by the force of the atmospheric current upon them. This turning in of the upper portion of a pair of œdematous aryteno-epiglottic folds can be recognized laryngoscopically, and occasionally directly, in cases of incised wound through the hyothyroid membrane, even though the inferior portions of the swollen tissues are drawn apart by the separation of the arytenoid cartilages in the inspiratory act. After a while breathing becomes obstructed in the expiratory phase of the process also. The usual physical phenomena of suffocation are recognized: general agitation; anxious countenance; face flushed at first, and then livid; lips and tongue blue; eyeballs projecting; respiration shallow, hurried, and perhaps spasmodic or gasping; pulse small, quick, and frequent. Death may ensue in the first paroxysm, or in any subsequent one.

In acute œdema the paroxysms are usually abrupt, violent, and irregularly recurrent at intervals of a few hours. Slight agitation or emotion may bring them on.

In chronic œdema they usually follow steadily increasing dyspnoea, culminating in a paroxysm which is followed by relief to the difficulty of breathing, and does not recur for a few days, or even for a few weeks. The intervals gradually diminish, until finally several paroxysms a day may occur, those at night being the most severe.

The subjective symptoms of subglottic œdema of the larynx are similar to those of acute laryngitis, with the addition of mild symptoms of ordinary œdema of the larynx; but the strident dyspnoea is present in both phases of respiration, and is attended with a noisier hoarseness. There is more cough, and more expectoration of mucus, rings of fibrinous sputa being sometimes ejected. Dysphagia does not occur unless there be œdema of the upper aperture of the larynx also.

Diagnosis.—The tongue, palate, uvula, tonsils, and even the pharynx, sometimes show evidence of infiltration—usually when the œdema is the result of acute inflammation; but in many instances there is no manifestation of disease in these structures. In some cases the œdematous epiglottis is visible without depression of the tongue; in others it is brought into view by that manipulation. If the tongue be so far depressed as to induce retching, the swollen aryteno-epiglottic folds will sometimes come into view.

The marked inspiratory dyspnoea, with comparative freedom in the expiratory phase of breathing, is to be regarded as a characteristic symptom, though by no means pathognomonic. According to Billard,¹ œdema of the larynx in the new-born is indicated by a peculiar, bleating cry, veiled and incomplete. Digital exploration will readily detect œdema of the epiglottis or of the aryteno-epiglottic folds; but the manipulation has been known to produce serious suffocative phenomena.² Forward and upward manipulation

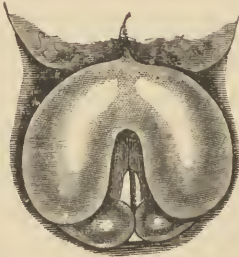
¹ Op. cit., p. 489.

² Trousseau, Clin. Mèd., New Syd. Society's transl., vol. iii. p. 98.

of the larynx, externally, affords no relief to the dyspnoea as it does in retro-pharyngeal abscess, and serves therefore as a method of discrimination.

Accuracy in diagnosis is assured at once by laryngoscopic inspection. The œdematous epiglottis presents itself as a gelatinoid, quivering tumor, varying in size from that of a peanut to that of a walnut. Its configuration varies. Occasionally it is constricted by the glosso-epiglottic ligament, so as to resemble two bladder-like projections instead of one. Sometimes it looks like a large, limpid sac overhanging the upper aperture of the larynx. The laryngeal surface does not favor accumulations of fluid; hence the œdema is usually confined to the lingual surface and the crest.

Fig. 1114.



œdema of epiglottitis.

Fig. 1115.



œdema of aryteno-epiglottic folds.

œdema of the aryteno-epiglottic fold, usually bilateral, appears, in the laryngoscopic image, as a pale pink or yellow, translucent or semi-translucent, pyramidal tumor, resembling in color an œdematous prepuce or an œdematous eyelid. As a rule, the ventricular band (false vocal cord) becomes obliterated into a mass continuous with the aryteno-epiglottic fold. When bilateral, the œdema is usually unequal. Sometimes these tumors are livid. They may attain the size of a pigeon's egg. The swollen folds of tissue project towards each other, and occlude the calibre of the upper portion of the larynx—the glottis of the ancients—hence, probably the term *œdema glottidis*. The space between them becomes diminished to a mere slit; and in pronounced cases, this slit becomes smaller during inspiration, from the pressure of the inspiratory current, which slightly forces its surfaces into contact. Sometimes, indeed, they stick together for a moment. During the expiratory phase of respiration they separate, at times sufficiently to disclose the vocal bands beneath them. Gougenheim¹ denies this downward and inward movement by atmospheric pressure, and asserts that the œdematous folds separate in inspiration, following the movements of the vocal bands. He attributes the dyspnoea to spasm. That he is correct as far as concerns the cases observed by himself, there is no reason to doubt; but I have noticed the action above described, not only laryngoscopically, but likewise directly, in the œdema consecutive to suicidal wounds of the neck which exposed the larynx to direct view.

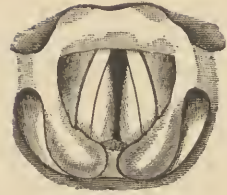
In a case of acute inflammatory œdema of the vocal bands recorded by Semon, “the upper surfaces of these structures were quite rounded, so that they looked semi-cylindrical,” and “their color was changed into a bright, semi-transparent red.”

¹ Annales des Maladies de l'Oreille et du Larynx, etc., p. 125, Juillet, 1883.

In subglottic œdema of the larynx, laryngoscopic inspection reveals projecting tumors beneath the vocal bands. (Fig. 1116.)

The affections from which œdema of the larynx is to be discriminated are thymic asthma, stridulous laryngitis, croup, the presence of a foreign body in the air-passage, that of a tumor in the larynx, and compression of the air-passage by an aneurism of the aorta or of the innominate artery. The history of the attack, and inspection with the laryngoscope, will usually suffice for diagnosis. In antelaryngoscopic days, the symptoms due to compression from aneurism were sometimes attributed to œdema of the larynx (Cruveilhier), and tracheotomy even was performed in consequence. (Lawrence, Cheyne.)

Fig. 1116.



Subglottic œdema of the larynx.

Prognosis.—The danger of suffocation, which may come on with little warning, or with none at all, renders the prognosis grave whenever the œdema is extensive or bilateral, or attended with spasm of the glottis. Suffocation has been known to occur at the apparent onset of the œdema, before it has been possible to know what was the matter. Left to itself, a serious case of œdema will be apt to terminate fatally in from three to five days, sometimes by suffocative apnœa, sometimes by slow apnœa, sometimes by supercarbonization of the blood, even after the respiration has become comparatively tranquil.

Idiopathic, serous œdema, in robust subjects, affords a favorable prognosis, provided that prompt measures are taken for relief. Sero-purulent and purulent œdema offer a far less favorable prognosis. That of the œdema attending aneurisms, malignant tumors, and tuberculosis, is always unfavorable. The prognosis is doubtful in the deuteropathic œdema of acute constitutional disorders, such as enteric fever, smallpox, scarlatina, and erysipelas. Both immediate and ultimate prognosis are less favorable in subglottic than in supraglottic œdema.

The prognosis of chronic œdema of the larynx is not so immediately serious as that of acute œdema, but the hope of ultimate recovery is much slighter; and tracheotomy may be indicated for the permanent establishment of an artificial opening for respiration.

Treatment.—The best treatment for œdema of the larynx is to make a few punctures or incisions into the tumid mass, with a well-curved knife protected to within a line or two of its point, so as to give vent to the fluid. Special knives have been constructed for the purpose, which are easier to manipulate, but in an emergency a gum-laneet will be found quite efficient. If practicable, the little operation should be performed under guidance of laryngoscopy; otherwise the forefinger of the disengaged hand may be relied upon as the guide for the knife. It is not necessary to make an intra-laryngeal cut for œdema of the aryteno-epiglottic fold. An incision in the exterior wall will do just as well, and will avoid the entrance of blood into the air-passage. A little spasm follows the cut, and seems to help force the serum out. The hemorrhage is insignificant in most instances, amounting usually to less than a drachm, and rarely to more than two or three; but occasionally the bleeding may be profuse, and may require persistent coughing to expel it.¹ Bleeding is more apt to be profuse from scarification of the epiglottis than from scarification of the aryteno-epiglottic fold. When the hemorrhage is slight, it may

¹ Cohen, op. cit., p. 451.

be encouraged by warm-water gargling, or by inhalations of steam. If the first scarification be effective, a second is rarely required in acute œdema. In chronic œdema, repetitions may be called for from time to time.

When the effused products are semi-solid, they cannot be evacuated by scarification. Should the hemorrhage from the operation fail to give relief under such conditions, tracheotomy is indicated. Its postponement surrenders the patient to the risk of suffocation.¹ Too long a delay in tracheotomy may favor death by congestion of the lungs or brain, even though free respiration be re-established² for a few hours or a few days. Tracheotomy is preferable to laryngotomy, inasmuch as this sort of laryngeal œdema may extend down to the point of election for laryngotomy, and that operation may, therefore, fail to afford relief. Respiration having been secured by the tracheotomy, ample time will be afforded for deliberate scarification of the œdematous tissues—a proceeding which will be required should deglutition be impeded by the swelling. It is sometimes practicable, as suggested by Stromeyer, to rupture the swollen mucous membrane by strong pressure with the finger at the moment of digital exploration. In one instance of œdema of the epiglottis, I was enabled to perform this little operation with success.

Pressure and scarification failing to afford relief, tracheotomy is indicated at once, lest suffocation ensue before absorption can be induced by constitutional measures. Cases recover sometimes under antiphlogistic treatment,³ and spontaneous subsidence occurs occasionally, too, within a few hours without treatment; but it is better by far, as regards the safety of the entire number of patients, to perform tracheotomy than to run any risk. Indeed, tracheotomy once indicated in a case not under continuous professional supervision, had better be performed as a precautionary measure even though the urgent symptoms have subsided. Otherwise death may ensue in a fresh suffocative attack.⁴

Frequent compression of the parts to promote absorption (Thuillier), seems hardly worthy of commendation. Catheterization of the larynx usually fails to afford any relief, though Chiari claims good results from this procedure in the acute œdema attending nephritis and inflammation in the vicinity of the larynx.⁵

In cases of moderate severity, unattended with laryngeal spasm, iced applications externally, and ice in the mouth, will sometimes favor absorption of the effused serum, and obviate any necessity for resort to the knife.

In *hemorrhagic œdema*, puncture or incision of the mucous membrane is indicated to give vent to the effused blood. Pellets of ice in the mouth, and the administration internally of turpentine or ergot, or the hypodermic administration of the latter, are likewise indicated. Should suffocative apnoea be threatened, tracheotomy becomes indicated for the reasons already alluded to.

In *sub-glottic œdema*, scarification is the theoretic remedy; but the location of the lesion renders it impracticable to follow the indication. In mild cases, the constitutional influence of mercurials may be tried in the first instance. Tracheotomy once indicated, should not be long deferred, lest, as in an unfortunate instance in my early practice, it may fail to save the patient from the lethal effects of prolonged supercarbonization of the blood.

In some cases of this kind it becomes impossible to dispense with the

¹ For a recent case in point, see Jour. de Méd. de Bordeaux, 24 Juin, 1883.

² Pitman and Page, Lancet, April 21, 1860, p. 392.

³ Wilson, Med. Chir. Trans., vol. v. p. 156; Arnold, *ibid.*, vol. ix. p. 31; Anderson, Edinb. Med. and Surg. Jour., vol. x. p. 284; Roberts, Med.-Chir. Trans., vol. vi. p. 135. Roberts's patient died in a subsequent attack fourteen years afterward.

⁴ Jour. de Méd. de Bordeaux, 24 Juin, 1883; Med. and Surg. Reporter, Sept. 8, 1883 p. 276.

⁵ Monatsschrift für Ohrenheilkunde, Juni, 1881; Rev. mens. de Lar., etc., Janv. 1882, p. 25.

tracheotomy tube, the effused matters failing utterly to undergo absorption under any treatment.

In *chronic œdema*, tracheotomy can do little more, in many cases, than put the larynx at rest for a time. In many instances it but adds additional irritation to the evils already in existence. It does not facilitate the cure of the affection. In case of threatening suffocation, it is demanded as in similar conditions under other circumstances.

Scarification, followed by topical applications of strong astringents, such as solutions of nitrate of silver, chloride of gold, chloride of zinc, and sulphate of copper, sometimes reduces the tumefaction for a time. Sedative inhalations relieve the local distress. Blisters and other counter-irritants are rarely efficacious, and are sometimes injurious. These cases, as a rule, are hopeless.

FRACTURES OF THE LARYNX AND TRACHEA.

FRACTURE OF THE LARYNX.—Fractures of the larynx are not frequent. They are commonly the result of great violence. They are usually associated with a wound of the integument, but the reverse occasionally occurs.¹ Sometimes they are associated with fractures of the hyoid bone, and occasionally with fractures of the lower jaw and of the extremities.² There may be a single fracture, or several fractures. Multiple fracture of the cricoid cartilage is rare.³ Ossification of the cartilages is assigned as the chief cause of multiple fracture. The fracture may be complete or incomplete. It may be simple, compound, complicated, or comminuted.

But little was known of fracture of the larynx before the eighteenth century. The earliest record is usually attributed to Morgagni,⁴ and among the earlier cases may be mentioned those of Valsalva (1703), Weiss (1745), Colombo, and Plink (1775).⁵

The subject has been particularly studied or discussed by Malgaigne,⁶ by Cavasse,⁷ by Gurlt,⁸ by Hunt,⁹ by Fredet,¹⁰ by Hénoque¹¹—who sums up the conclusions of the writers referred to, and others with them—and by Caterinopoulos.¹²

Usually the fracture is limited to the thyroid and cricoid cartilages. I know of no positive record of fracture of an arytenoid cartilage, save an undefined "articular fracture" of the right arytenoid in a case cited by Cavasse. The arytenoid cartilages, moving so freely on the cricoid, are much more apt to suffer luxation. In extensive injuries, indeed, such a luxation is not infrequent, and is often a serious element of danger. In many cases both the thyroid and the cricoid cartilages are fractured. The thyroid suffers much more frequently than the cricoid when but one cartilage is broken. In 52 cases collected by Hénoque, the thyroid alone was fractured in 23, the cricoid alone in 7, and both cartilages in 7. Durham¹³ adds seventeen cases, four of which are personal, to the fifty-two collected by Hénoque,

¹ Macler, *Union Méd.*, 1864, p. 142.

² Bell, *Lancet*, Oct. 21, 1871, p. 571.

³ Treulich's case, *infra*.

⁴ Op. cit., epist. xxix.

⁵ Masucci, *Arch. Ital. di Lar.*, Anno i., 1881-2, p. 110.

⁶ *Traité des fractures et des luxations*, tome i. Paris, 1847.

⁷ *Essai sur les fractures traumatiques des cartilages du larynx*. Thèse de Paris, 1850.

⁸ *Handbuch der Lehre von den Knochenbrüchen*, Theil. II; Lief. i. Hamm, 1864.

⁹ *Am. Jour. Med. Sciences*, April, 1866, p. 378.

¹⁰ *Gaz. des Hôp.*, 1868, Nos. 90, 91; *Quelques considérations sur les fractures traumatiques du larynx*. Paris, 1868.

¹¹ *Gaz. Hebdomadaire*, 25 Sept., 2 Oct., 1868.

¹² *Étude sur les fractures des cartilages du larynx, et leur traitement par la thyrotomie immédiate*. Thèse de Paris, 1879.

¹³ Op. cit., 3d edit., vol. i. p. 749.

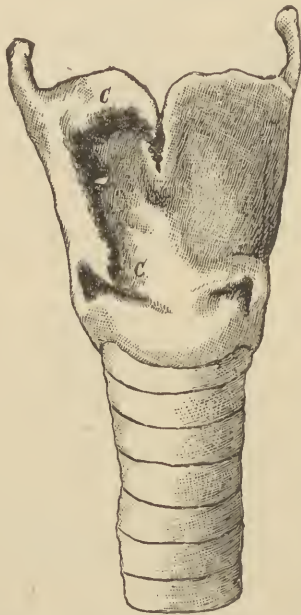
with the following summary: indefinite "fractures of larynx" 7; thyroid only 30; cricoid only 11; thyroid and cricoid 9; thyroid, cricoid, and trachea 2; cricoid and trachea 3; thyroid and hyoid bone 4; thyroid, cricoid, and hyoid bone 2; cricoid, trachea, and hyoid bone, 1.

Ossification of the cartilages is hardly the important element in the injury that it was formerly supposed to be, for of 46 cases of fracture of the larynx and trachea collected by Gurlt,¹ 16 occurred in individuals between nine and thirty years of age, 12 in males and 4 in females. The thyroid cartilage alone was injured in 6 of these 16 cases, the cricoid alone in 1, the trachea alone in 1, the "larynx" in 2. Of the 27 cases collected by Hunt, 5 had occurred in children.

Fractures are sometimes associated with contused, incised, lacerated, and gunshot wounds of the integument and of the larynx itself.

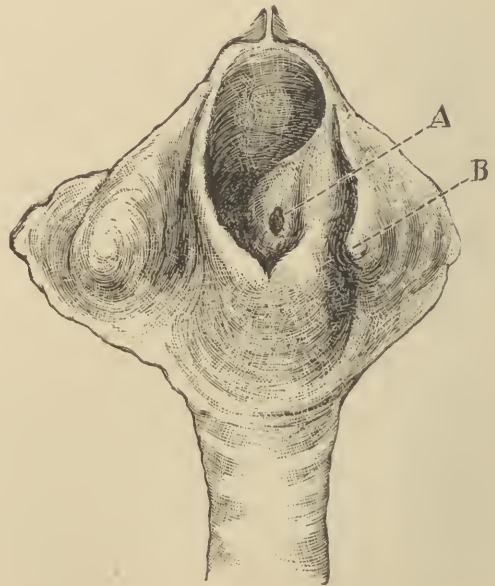
The *causes* of fracture of the larynx are attempts at choking with the hand, whether premeditatedly or during a struggle; blows with the fist, foot, or a hard weapon, such as a billet of wood; falls upon hard objects; awkward hanging;² and crushing violence. Mackenzie³ records one from an acrobatic jump upon the patient's neck. Treulich records a multiple fracture in a patient whom a horse seized by the throat and lifted from the ground.

Fig. 1117



Fracture of thyroid cartilage. CC, Line of fracture.
(Roe⁴)

Fig. 1118.



Fracture of larynx A, Rupture of mucous membrane where hemorrhage took place; B, Upper cornu turned inward. (Roe.⁵)

Fracture of the *thyroid* may be single or multiple, complete or incomplete. The single fracture is usually vertical. Its most frequent seat is anteriorly,

¹ Op. cit.

² For a recent example, see Porter, Archives of Laryngology, vol. i. p. 142 (illustrated).

³ Op. cit., p. 402.

⁴ Archives of Laryngology, April, 1881, p. 129.

⁵ Ibid., p. 130.

at the middle line or a little to one side, the intermediate cartilage usually adhering to the larger fragment (Fig. 1117). Multiple fractures may occur in one wing only or may involve both. Stellate fractures are sometimes produced by gunshot injuries.

Fractures of the *cricoid* cartilage are usually vertical or slightly oblique in direction. They may occupy the posterior, the lateral, or the anterior portion of the cartilage. They are usually single, but may be multiple. A case is recorded in which the cartilage was broken into three fragments.¹

Fractures may be complicated by disrapture of the larynx from the trachea;² by œdema of the larynx or epiglottis;³ by laceration or rupture of the mucous membrane (Fig. 1118); by displacement of fragments so as to occlude the calibre of the respiratory passage; by clotting of blood within it; in fact by nearly all the complications detailed in connection with contused, lacerated, and gun-shot wounds of the larynx.

A case has been recorded⁴ in which blood was effused in the neighboring parts to such an extent as to push the larynx over to one side.

Symptoms of Fractured Larynx.—The symptoms vary with the cause of the injury and with the extent of the lesions. Unconsciousness is sometimes an immediate result, not only in cases of fracture from manual compression,⁵ but in those from blows and falls upon hard objects,⁶ and in those from fire-arms.

The ordinary subjective symptoms are pain, dyspnœa, and cough. The cough is usually spasmodic or paroxysmal, and serves to eject both frothy and coagulated blood, and bloody mucus. The dyspnœa is usually severe, and is attended with lividity of the countenance. It progresses in some instances to threatening suffocative apnœa, with all the usual accompaniments of that condition. Coarse mucous rales may be heard in the larynx. Dysphonia usually exists to some extent, in some cases amounting to aphonia. Difficulty of articulation occurs in some instances, and occasionally absolute inability to speak. Pain is usually excited by swallowing or by handling the part. Sometimes it is constant.

The dysphagia, as in Mackenzie's case,⁷ which was examined laryngoscopically, may be found due to an inflamed and œdematous epiglottis.

In exceptional cases there may be but slight hoarseness, slight dysphagia, and slight pain or mere tenderness, with total absence of dyspnœa.

Should a laceration in the mucous membrane communicate with the site of fracture, emphysema of the throat and neck will be likely to occur. Such emphysema has been known to spread over the face, thorax, and back, down into the mediastinum, and even over the entire body. It is said to be more likely to involve the intermuscular connective tissue than that which is subcutaneous.

The suffocative symptoms may arise from serous œdema of the larynx, from hemorrhagic effusion, from accumulation of fluid or of clotted blood, or from occlusion by displaced fragments of broken cartilage and lacerated soft tissues. In some instances there has been but little dyspnœa at first, or none at all, and yet severe dyspnœa has suddenly ensued within a few hours, or as late as after several days of comparatively quiescent respiration. These

¹ Trenlich, *Vierteljahrschrift f. d. prakt. Heilkunde*, Bd. v. S. 129. 1876; *Centralbl. f. Chir.* 1876, No. 14.

² Wagner, *Centralbl. f. Chir.* 1883, No. 23.

³ Mackenzie, *op. cit.*, p. 402.

⁴ Stokes, *Dub. Jour. Med. Sci.*, May, 1869; cited by Durham.

⁵ Wagner, *Centralbl. f. Chir.*, 1883, No. 23; *London Med. Record*, October 15, 1883.

⁶ Roe, *loc. cit.*; Sajous, *Archives of Laryngology*, July, 1882.

⁷ *Op. cit.*, p. 402.

manifestations have been attributed to œdema in some instances, and to displacement of fragments in others.

The symptoms of incomplete fracture appear to be very slight in comparison to those of complete fracture. Although there is no absolute displacement of fragments, crepitus is said to have been elicited in some instances, when the parts were pressed upon for the purpose.

Diagnosis.—The history of wound or other injury, and the manifestations described as the symptoms, will indicate the character of the lesion. If the injury be the result of a direct blow or a fall, the neck may be flattened anteriorly; if the result of choking or other form of strangulation, it may be flattened laterally. Some evidence of bruise, contusion, or external wound is usually observed. Ecchymosis is commonly present, with tumefaction externally. Early swelling is attributed to extravasated blood; late swelling to inflammation. Abnormal mobility of the cartilages can usually be detected on manipulation. In severe lesions there may be deformity from overriding of the fragments. In others, there may be no displacement at all. (Gibb.) Crepitation may be produced by manipulation of the fragments in some instances; but care must be taken not to be deceived by the crepitation normally produced by lateral movements of the larynx, or by slight pressure against the vertebral column. The horn of the right cartilage may be anomalously inclosed in the lateral thyro-hyoid ligament,¹ or may be entirely absent.²

Prognosis.—The prognosis is always grave, especially so when the *cricoid* cartilage has suffered fracture. But two instances of recovery after fracture of the cricoid seem to be on record.³ In the entire 28 instances of fracture of this cartilage tabulated by Durham,⁴ not one patient recovered. Wagner's cases⁵ furnish additional examples. The fatal result is probably attributable to the great contusion and laceration sustained by the bloodvessels, nerves, and other soft parts, in an injury sufficiently severe to fracture this very strong cartilage. Fractures of the *thyroid* cartilage are usually fatal, only 10 patients having recovered in Durham's list of 30 cases of fracture of that cartilage only, and 2 in 4 cases of fracture of the thyroid complicated with fracture of the hyoid bone. Guanek's case⁶ also terminated fatally. A patient referred to my clinic from the surgical out-door department of Jefferson College Hospital, and placed under care of the clinical chief, recovered with a weak voice—crepitation being reported to have been as distinct four months after the injury as it had been on its receipt.⁷ Harrison⁸ likewise reports a case which terminated favorably. In Treulich's case of recovery,⁹ there had been fracture of the thyroid and double fracture of the cricoid, with rupture of the trachea. It is presumable that the repair is by fibro-cartilage as in other wounds of the same parts.

Severe cases often terminate fatally at once, or within a few hours; usually by suffocative apnœa from extravasation of blood beneath the intra-laryngeal mucous membrane—hemorrhagic œdema—or from displacement of fragments occluding the calibre of the respiratory tract, or from accumulation of blood within it. Extensive injuries to the superjacent soft parts, or to other portions of the body, help to exhaust the forces of the patient, and render the prognosis still more gloomy.

¹ Luschka, Virchow's Archiv, 19 Marz, 1868, S. 478.

² Cohen (Mütter Lectures), Phila. Med. Times, April 12, 1873, p. 435; op. cit., p. 609.

³ Treulich, loc. cit., cited by Ashhurst (Principles and Practice of Surgery, 3d ed. 1882, p. 351): The cricoid was fractured in two places, isolating the anterior median segment; Masucci, Arch. Ital. di Lar., Anno I., 1881-2, p. 108.

⁴ Op. cit., 3d edit., vol. i. p. 749.

⁵ Loc. cit.

⁶ Wien. med. Woch., 1 Sept. 1883.

⁷ Lancet, June 1, 1882.

⁸ Loc. cit.

⁹ Sajous, Archives of Laryngology, July, 1882.

⁹ Loc. cit.

Unless forestalled by precautionary tracheotomy and insertion of a tube, suffocative phenomena may intervene at any time from œdema, displacement of fragments, or occlusion of the calibre of the air-tube with blood-clots.

Recovery occupies a number of weeks. In complicated cases, three months or more may be consumed in the process.

Suppuration ensues during repair; and this may entail cicatricial stenosis. The injured cartilages may undergo necrosis in part, and the dead portions may be expectorated, or may be discharged externally.

Suppurative inflammation of the connective tissue sometimes follows the emphysema. Death has taken place in this way by mediastinal emphysema and secondary pericarditis;¹ by pleurisy from contiguity to the burrowing abscess; and by pneumonia (Wagner's case) and broncho-pneumonia.² Permanent hoarseness, or even aphonia may remain after recovery.

Treatment.—Recovery is so rare unless tracheotomy has been performed at some stage of the treatment, and the danger of sudden suffocative apnoea is so great under almost any other method of management, that prudence seems to suggest the propriety of a prophylactic tracheotomy in every instance, as a precautionary measure, for reasons mentioned in discussing the treatment of incised and gunshot wounds of the larynx (p. 237). Of the entire sixteen cases of recovery out of the sixty-nine tabulated by Durham, in nine the patients were saved by timely opening of the air-passage, and a tenth was restored by long-continued artificial respiration after tracheotomy, although he succumbed to broncho-pneumonia a fortnight later.³ To this list of recoveries after tracheotomy, may be added the exceptional case of Treulich, already referred to.

Better far than an unnecessary tracheotomy should be occasionally performed without detriment to the patient, than that a number of cases should be allowed to terminate fatally for want of it.⁴

The safety of the patient from suffocation being apparent, or having been secured by the operation recommended, the displaced fragments should be carefully adjusted, the crico-thyroid membrane being incised, if necessary, to facilitate their reposition by means of catheters, probes, or the little finger passed through the artificial opening—a procedure which practically adds nothing to the peril of the patient. No attempts should be made to retain the fragments in position by sutures, for reasons previously mentioned (p. 238). Any wound in the soft parts may be closed by sutures and adhesive strips; an opening being left for drainage, and kept patulous by a strip of lint or a drainage-tube. The treatment of emphysema and other complications, and the after-treatment altogether, should be conducted on the same principles as that of wounds of the larynx generally.

If the fragments of the thyroid cartilage fail to unite, or if stenosis cannot be prevented, extirpation of the partially detached portion, and even removal of half of the larynx has been suggested;⁵ and in a case reported by Billroth, this partial operation was performed, and a good voice retained.

FRACTURES OF THE TRACHEA.—Fractures of the cartilages of the trachea occur under similar conditions to those under which fractures of the larynx are met with. In some instances the injury is confined to the trachea; in most it is associated with fracture of the larynx, of the hyoid bone, or of both. Gurlt⁶ records nine cases of fracture of the trachea, in four of which

¹ Steiner, Wien. med. Woch., Bd. xviii. S. 15. 1867,

² Couper, Med. Times and Gaz., Dec. 18, 1880, p. 695.

³ Op. cit., 3d edit., vol. i. p. 750.

⁴ See especially Fredet, op. cit., p. 5.

⁵ Wagner, loc. cit.

⁶ Op. cit., S. 316.

that structure alone was involved. Dr. Corley¹ records a case following a squeeze of the throat in a domestic quarrel, in which three of the upper rings of the trachea had suffered fracture. A comminuted fracture is reported by Drummond,² in which the cartilaginous rings were crushed by a fall upon the exposed spindle of a chair from which the upper rung was missing.

Symptoms.—These are similar to those of fracture of the larynx: severe dyspnoea and rapidly extending emphysema. There is no elevation of dislocated fragments, no abnormal mobility, and no crepitation. False crepitus may be due to emphysema or to extravasated blood.

Diagnosis.—The character of the accident occasioning the dyspnoea and emphysema, and the evidence of external injury, will commonly indicate the nature of the case; but the absence of the physical signs of crepitus and deformity may render the diagnosis difficult.

Prognosis.—This is unfavorable, especially if the trachea be not freely opened for re-establishment of the respiration. Fracture of the trachea seems more promptly fatal than fracture of the larynx. Of seven cases collated by Gurlt, death followed in five of them from an hour and a half to a day after the accident. In one only was life saved, and then by tracheotomy after apparent death, the accumulated masses of blood and mucus being removed, and artificial respiration instituted. Recovery ensued in the case of comminuted fracture recorded by Drummond.

Treatment.—This is similar to the treatment of fracture of the larynx. The trachea should be laid freely open, either at the injured part or below it, and a tube inserted, through which respiration may be carried on with safety. The subsequent treatment should be like that adopted for similar wounds of the trachea.

TRACHEOCELE.

Tracheocele is the term applied to a sacciform diverticulum of the mucous membrane of the trachea³—a hernial protrusion externally, between two of the cartilaginous rings or through a congenital fistula. A tumor is thus formed on the external wall of the air-tube, the contents being air, and the cyst-wall mucous membrane. Its position may be anterior or lateral. The lesion is quite rare. The tumors vary in size from the bulk of peas (Gross) to that of hens' eggs. The tumor is usually single; occasionally it is bi-lobed. Faucon⁴ relates one instance of ten years' standing, in which the tumor was divided into an upper and a lower lobe. Devalz⁵ narrates a case in which the tumor was composed of two principal lobes; one passing under the muscles of the neck to the right, and the other under the clavicle to the left. Eldridge⁶ likewise records a bilateral case. In a thoughtful article he presents a table of nine cases, two of which, however, were not really tracheoceles, and were not so recorded by their observer.⁷ D  tis⁸ reports a case of median tracheocele in the practice of Godefroy, and reproduces eight cases published by other writers.

Tracheocele has been observed much the more frequently in males, and usually in the adult. Leriche⁹ has recorded a case of double tracheocele in

¹ Dub. Jour. Med. Sci., October, 1877, p. 346.

² Brit. Med. Jour., Dec. 28, 1872; Boston Med. and Surg. Jour., Jan. 16, 1873, p. 72.

³ Rokitsansky, Manual of Pathological Anatomy, vol. iii. p. 48. Philadelphia, 1855.

⁴ Gaz. des H  p., 1874, p. 77.

⁵ Gaz. Heb  d., 24 Juin, 1873, and Gaz. M  d., 15 Nov. 1873, p. 612.

⁶ Am. Jour. Med. Sci., July, 1879, p. 70.

⁷ Cohen, Diseases of the Throat, etc., p. 395. 1872.

⁸ Contribution    l'  tude du trach  ocele. Th  se de Paris, 1882.

⁹ Comptes-rendus de la Soc. des Sciences M  d. de Lyon, 1868; reproduced by D  tis, loc. cit.

an infant eight months of age. Faucon¹ has recorded an instance in a child eighteen months old, in which the tumor was seen, during a plastic operation, to have been the result of a defect in the lining membrane of the trachea—the only instance of any anatomical examination of tracheocele with which I am acquainted. Imperfect descriptions of congenital examples have been recorded by Gohl² and by Fischer.³ Gohl's case was associated with bronchocele.

Under the title of *aerial or vesicular goitre*, Larrey⁴ has mentioned some cases of what appears to have been circumscribed emphysema of the neck, occurring in the blind Muslimim who chant verses of the Koran every hour from the tops of their minarets—the pouches being compared to the submaxillary pouches of monkeys. He also mentions two cases in drill-sergeants. A number of similar cases, with aerial tumors more or less evanescent, are recorded by various observers as having followed straining of the voice, violent cough, violent vomiting, and violent physical effort while holding the breath, two instances of this kind being mentioned in my work, already quoted.⁵ But these are not cases of tracheocele, since there is no evidence of the existence in them of a sac formed at the expense of the mucous membrane of the trachea, which seems necessary to constitute that affection.

Pathogenetically, tracheocele seems due in most instances to a congenital defect in the closure of a branchial cleft. Through the fistula thus left, the tracheal mucous membrane is forced by the expulsive power of the expiratory current of air in violent coughing, or in straining with closed glottis. The sac produced in this way gradually enlarges, and is presumed to undergo thickening by inflammatory processes. Laceration of the air-tube in violent efforts with closed glottis, as during defecation and parturition, has been regarded as a cause of this affection, but it is not improbable that a congenital defect may have existed even in those instances in which such laceration has occurred.

Symptoms.—The subjective symptoms are dyspnœa, occasionally noisy and sometimes threatening in character; a hoarse, low, muffled voice; and aphonia and even dysphagia in some instances. In Devalz's case the pronunciation of each syllable was accompanied by a peculiar cooing, said to be faithfully imitable by pronouncing *ouvvouou* in a very deep tone.

The objective symptoms are connected with the presence of a compressible, gaseous tumor, sometimes resembling a cystic goitre, just above the sternum or not higher than the cricoid cartilage, whether anterior, lateral, or bilateral. This tumor enlarges somewhat during the expiratory phase of the respiratory act, and conversely diminishes in size during inspiration. Marked enlargement can be produced on forced expiration with closed mouth and nose, but this enlargement is much less than that observed to take place during a paroxysm of intense dyspnœa. In some instances the tumefaction is paroxysmal for some months before it becomes constant.⁶ Laryngoscopically, the action of the laryngeal muscles has been seen to be sluggish (Eldridge), and this condition may partly account for the enfeeblement of voice. In other instances (Devalz), laryngoscopy has shed no light on the case.

Diagnosis.—The history of the sudden appearance of the tumor, its gradual enlargement, its increase under the force of the expiratory current of the breath, the control of some of this enlargement by exercising deep pres-

¹ Loc. cit.

² Ammon, *Die angeborenen chirurgischen Krankheiten des Menschen*. Berlin, 1842; cited by Eldridge (loc. cit.).

³ Pitha und Billroth, *Handbuch der Chirurgie*, Bd. III. Lief. i. S. 3.

⁴ *Clinique Chirurgicale*, tome ii. p. 81. Paris, 1829.

⁵ *Diseases of the Throat*, etc.

⁶ Eldridge's case, loc. cit.

sure at some point of the base of the tumor, the emphysematous sensation of crepitus on pressure of the mass, and its diminution or disappearance under equable compression, all point to the nature of the lesion. Palpation gives the sensation of a sac containing air.¹ Auscultation may reveal the normal tracheal murmur. (Devalz.) Tympanic resonance may be elicited on percussion in some cases. (Faucon, Lize, D  tis.)² Tracheocele may be mistaken for goitre. The distinction could be made by an exploratory puncture, for in Eldridge's case the needle gave exit to a stream of air forcible enough to extinguish a lighted match. Discrimination from circumscribed emphysema would depend chiefly on the discovery of a sac by palpation, but the distinction from emphysema resulting from rupture at the summit of the lung, as in Lize's case, might prove difficult.

Prognosis.—This is said to be favorable by D  tis, who reports a case cured after six weeks' compression. Other records seem to indicate the hopelessness of doing much more than preventing increase of size. No danger to life, however, is to be apprehended. The supposed cures have occurred in cases of emphysema rather than of tracheocele.

Treatment.—The treatment should consist in manipulation of the tumor, so as to drive as much air as possible out of it into the trachea, followed by the application of continuous pressure at the seat of control of the expansion of the tumor, so as to excite obliterative inflammation in the neck of the sac at the tracheal orifice. Dyspnoea may require special treatment by anodynes. Godefroy cured his patient within six weeks by permanent compression with a sort of hernia-bandage, and Leriche³, too, promptly cured his patient by compression. Others have simply advised the use of an apparatus, to hide the deformity and prevent any further distension of the sac.

LUXATION OF THE CARTILAGES OF THE LARYNX.

Luxation of the cartilages of the larynx is rare. The cause may be traumatic, and proceed from without, or may be pathological, and proceed from within.

From without, it is the result of direct violence; in most instances, perhaps, associated with fracture of the larynx. Disarticulation of an *arytenoid cartilage* from the cricoid is the most usual form of the lesion. Disarticulation of the lower horn of the *thyroid cartilage*, in connection with other lesions, has been recorded by Holden⁴ and mentioned by Mackenzie,⁵ the cause in the former instance having been a severe blow or kick during a drunken brawl, and in the latter instance an accidental blow with the side of the hand.

From within, the cause is usually cicatricial contraction of the overlying or adjacent soft parts. In two instances, reported by Stoerk,⁶ of luxation of the left arytenoid cartilage transversely inwards, the lesion was observed in adult males with falsetto voices, and in both the dislocated arytenoid was seen laryngoscopically to be immensely tumefied, the opposite cartilage being pushed out of position. The vocal bands were seen to be permanently in the position occupied in paralysis of the posterior crico-arytenoid muscles. One case was attributed to cicatricial contraction after diphtheria; but no assignable cause could be detected for the other. A case supposed during life to have been one of paralysis of the muscles mentioned, was discovered after death to be one of dislocation of both arytenoids on the interior

¹ Faucon, Eldridge (loc. cit.).

² Op. cit.

³ D  tis, op. cit.

⁴ Am. Jour. Med. Sci., Jan. 1873, p. 129.

⁵ Op. cit., p. 541.

⁶ Wien. med. Woch., No. 50, 1873; London Med. Record, May 15, 1879.

surface of the plate of the cricoid cartilage, their bodies lying horizontally, and being closely united by cicatricial tissue.¹ In this instance, likewise, the lesion was attributed to contraction of a syphilitic cicatrix in the posterior wall of the larynx. As far as these meagre records are available, they seem to indicate that cicatricial contraction of an ulcer may be regarded as a cause of the dislocation.

Judging from the laryngoscopic image alone, unsupported by post-mortem evidence, or by the published observations of other writers, it has seemed to me that luxation or subluxation of a *supra-arytenoid cartilage* is an accident of occasional occurrence. In several subjects, principally singers who have become hoarse after unusual vocal exertion, I have noticed the supra-arytenoid cartilage of one side to incline decidedly forward and inward, in marked contrast to the erect position of the cartilage of the other side. The lesion does not seem to be of any special significance.

Symptoms.—The symptoms of dislocation of an arytenoid cartilage are not characteristic. They comprise difficulty in respiration and in phonation, with other manifestations due to the concurrent injury or disease which has occasioned the lesion. The symptoms described in Holden's case of dislocation of the inferior cornu of the thyroid cartilage—namely, acute pain, sense of suffocation, hemorrhage, dyspnea, dysphagia, and aphonia—are indicative of concurrent contusion of the larynx.

Diagnosis.—As reported in the three instances cited, the laryngoscopic image in dislocation of the arytenoid cartilages presents a close resemblance to that of paralysis of the dilating muscles of the larynx; a circumstance which might be regarded as liable to induce a mistake in diagnosis, were it not for the recognition of the displacement of the cartilage. The diagnosis must rest chiefly on laryngoscopic inspection, in cases of internal origin, and on direct inspection and palpation in cases of external origin. In Holden's case of dislocation of the inferior cornu of the thyroid cartilage, the point stuck out so as to present a prominence readily recognized.

As the result of ulcerous processes in tuberculosis, in typhosis, and in syphilis, an arytenoid cartilage may become detached from its seat, and hang over into the interior of the laryngeal tube; but this is hardly a luxation in the strictly surgical sense of the term.

Prognosis.—The prognosis as regards reduction of the dislocation of an arytenoid or supra-arytenoid cartilage is unfavorable. As regards the life of the patient, it depends upon the position occupied by the displaced cartilage. If it occlude the glottis, tracheotomy and permanent retention of the canula may readily become necessary to insure due freedom of respiration. The prognosis in dislocation of the inferior cornu of the thyroid cartilage seems to be unfavorable, likewise, judging from the record of Holden's case, in which attempts at reduction were unavailing.

Treatment.—A dislocated cartilage, complicating a gunshot wound or a fracture of the larynx, should be removed, as there are no means of retaining it in position. In cases similar to those cited in the text, tracheotomy might be required, as mentioned under the heading of prognosis. In case of dislocation of the horn of the thyroid cartilage, attempts might be made to retain the parts in apposition by a compress and bandage, or by traction with adhesive strips.

¹ Sidlo, cited by Ziemssen (*Cyclopædia of the Practice of Medicine*, vol. vii. p. 968. New York, 1876).

FOREIGN BODIES IN THE AIR-PASSAGES.

Water, food, or mucus, frequently, and something that should not have been put in the mouth, occasionally, "goes the wrong way," or gets into the air-tube, when one laughs, coughs, talks, cries, or makes a sudden inspiration, with any of these things in the mouth. Ordinarily the substance is ejected in a fit of coughing, and the accident passes out of remembrance with a laugh and a sense of relief. When any difficulty occurs in thus ejecting the intruding substance, the individual, often an infant, is slapped on the back by a bystander, the head and chest being bent strongly forward; and then the matter is ejected by the combined agencies of succussion, cough, and gravity. In very many instances, however, and especially when some substance, foreign in the literal sense, is in the mouth, the intruder is not dislodged so readily, but remains temporarily or permanently imprisoned in the air-passage. It may be loosely confined, or may become firmly impacted, whether in the larynx, the trachea, or a bronchus; and if not released, it may suffocate the patient at once, or at any subsequent period, varying within the extreme limits of minutes or of years.

Foreign bodies gain access to the air-passage in diverse manners, both by way of the natural orifice, and by way of a perforation through its walls, whether from the exterior of the body or from the interior.

FOREIGN BODIES INTRODUCED BY THE NATURAL ORIFICE.—Sudden inspiration, whether voluntary, incautious, accidental, or forced, while a mass of food or a movable foreign substance is in the mouth, is by far the most frequent source of the entrance of foreign bodies into the air-passages. Among other substances thus introduced, the following may be enumerated: water, going down the wrong way;¹ detached plates with artificial teeth;² matters vomited during repletion;³ epileptic seizure,⁴ apoplexy, unconsciousness and paralysis,⁵ or anaesthesia;⁶ regurgitated chyme,⁷ curdled milk,⁸ or meconium; parasites from the alimentary tract,⁹ or from the nasal passages and adjoining sinuses; leeches carelessly applied to the mouth,¹⁰ or inhaled while drinking from a fountain, stream, or hydrant;¹¹ teeth dislodged or crushed into

¹ Monteggia, *Inst. Chirurg.*, cited by Guyon (*Dictionnaire Encyclopédique des Sciences Médicales*. Art. Larynx, p. 707. Paris, 1876); by Poulet (*Treatise on Foreign Bodies in Surgical Practice*, vol. ii. p. 5. New York, 1880); and by others—a fatal case.

² Craigie, *Edinburgh Med. and Surg. Jour.*, vol. xlii. p. 105. 1834; Wallace, *Boston Med. and Surg. Jour.*, vol. xvi. p. 205. 1837; Carpenter, *Guy's Hospital Reports*, 1st series, vol. vii. p. 353. London, 1842 (cited by Gross, *Foreign Bodies in the Air-Passages*. Philadelphia, 1854); Major, Case of tooth and plate in the trachea for 113 days. *Archives of Laryngology*, October, 1882, p. 350.

³ Ryland, *Diseases and Injuries of the Larynx and Trachea*, p. 198. Philadelphia, 1838—fatal case; Vidal (de Cassis), a fatal case, cited by Poulet (*op. cit.*). This patient had attempted to suppress emesis by putting his hand in front of his mouth.

⁴ *Dub. Jour. Med. Sci.*, March, 1881, p. 243—fatal cases.

⁵ Barnes, *Brit. Med. Jour.*, March 25, 1871, p. 321; *Ibid.*, September 16, 1876, p. 381—fatal cases.

⁶ Smyth, *Lancet*, October 3, 1874; Howse, *Brit. Med. Jour.*, September 16, 1876, p. 16—fatal cases; Sands, Briddon, *New York Med. Jour.*, October 20, 1883, p. 448.

⁷ Parrot, *Union Méd.*, No. 91, p. 167. 1868; *Gaz. Hebdom.*, p. 489. 1868; and a second case, *Lancet*, September, 1873.

⁸ Warren, *New York Med. Jour.*, May, 1882, p. 478 (illustrated)—fatal case.

⁹ Aronssohn, *Archives Gén. de Méd.* 1836, t. x. p. 44, cited by Durham (*op. cit.*, Am. ed. vol. i. p. 703); Fuerst, *Wien. med. Woch.*, No. 3, 1879—a fatal case; Norrnan, *Norsk. Mag. f. Lægevidenskaben*, 3 R., Bd. xi.; London *Med. Rec.*, March 15, 1882, p. 96—fatal case, attributed to croup.

¹⁰ Guyon, *Éléments de Chirurgie Clinique*. Paris, 1873.

¹¹ Lacratelle, *Gaz. de Santé*, 25 Fev. 1828; *Lancet*, vol. ii., 1828, p. 104; Ridrean, *Gaz. Méd. de l'Algérie*, 1869, Nos. 1, 2, *et seq.*; Massei, *Il Morgagni*, Ottobre, 1874, p. 750; Clementi, *Gazz. med. Ital.*, 1874, No. 48; *Arch. f. klin. Chir.*, Bd. xviii. H. 1, S. 194; R. de la Sota, *Revista méd. de Sevilla*, Nov. 1883, p. 20—the last four removed under laryngoscopy.

fragments during extraction,¹ or during operations upon the mouth;² false teeth³ or tobacco quids,⁴ dislodged during anæsthesia; unsecured corks, inserted to keep the jaws separated;⁵ sponges, detached in whole or in fragments⁶ during operations within the mouth or upon the air-passages;⁷ pus escaping from tonsillar,⁸ post-pharyngeal, and aryteno-epiglottic abscesses;⁹ blood from pulmonary hemorrhages, and from operations about the mouth¹⁰ and upper air-tract; detached pseudo-membranes; instruments broken off during operations on the larynx;¹¹ necrosed laryngeal cartilages;¹² necrosed nasal,¹³ palate,¹⁴ and cranial¹⁵ bones; illy made or corroded tracheotomy-tubes.¹⁶ Finally, the epiglottis impacted into the upper orifice of the larynx may be mentioned as an occasional foreign body.¹⁷ This accident usually occurs during eating, but may occur during the deglutition of saliva.

FOREIGN BODIES INTRODUCED BY WAY OF THE WALLS OF THE AIR-TUBE.—Foreign bodies may gain access to the air-passage from the outside, both by direct penetration, as in the oft-cited case of La Martinière,¹⁸ in which a pin attached to a whip-cord had penetrated the trachea; and by indirect transit, as in gunshot wounds (see p. 230). Fauvel¹⁹ has recorded at length an instance in which a bullet, that had lodged originally somewhere in the bones of the face, was found in the larynx ten years afterwards, and was spontaneously expelled from the left pyriform sinus. Tauber²⁰ removed a bullet from the same locality twelve years after a gunshot wound of the neck.

Wounds and perforations of the trachea and bronchi occasionally afford opportunity for the entrance of a foreign body. Fluids are the most frequent

¹ Hertz, *Dental Cosmos*, 1873, p. 478; *Hospital Gazette*, October 4, 1879, p. 496; *Med. Record*, November 4, 1882, p. 517.

² Aronsohn, cited by Poulet (op. cit.)—a fatal case.

³ Chaffers, *Brit. Med. Jour.*, April 20, 1872, p. 49.

⁴ Fischer, *Deutsche Ztsch. f. Chir.*, Bd. xv. S. 188.

⁵ *Medical and Surgical Reporter*, 1867; Agnew, *Principles and Practice of Surgery*, vol. iii. p. 45. Philadelphia, 1883.

⁶ Mears, during excision of the tongue; life saved by immediate tracheotomy. (Personal communication.)

⁷ Cohen, op. cit., p. 572.

⁸ Stokes, *Med. Times and Gaz.*, August 29, 1874, p. 251—a fatal case; Littlejohn, *Brit. Med. Jour.*, January 2, 1875, p. 161.

⁹ Vidal (de Cassis), cited by Poulet (op. cit.)—fatal case.

¹⁰ Freeman, *Practitioner*, Aug. 1883, p. 119.

¹¹ Schroetter, *Monatschr. f. Ohrenheilk.*, Bd. x. 1876, cited by Poulet—the hair from a brush; Voltolini, *ibid.*, Dec. 1879, and *London Med. Record*, July 15, 1880, p. 293—ends of a pair of laryngeal forceps, retained nine months.

¹² Hunter, O'Shea, Labbé, Bell, Gooch and Houston, Larrey (cited by Poulet); *Chvostek, Centralbl. f. d. med. Wiss.*, 30 Dec. 1882, and *Amer. Jour. Med. Sci.*, April, 1883, p. 581.

¹³ Lincoln, *Archives of Laryngology*, July, 1882, p. 276.

¹⁴ *Brit. Med. Jour.*, 1873, cited by Poulet.

¹⁵ Coupland, *Lancet*, May 31, 1884, p. 984—fatal case.

¹⁶ This source of the accident, so readily avoided by proper circumspection and admonition, is so inexcusable that I desire to emphasize the point with quite an array of references: Porter, *On the Larynx and Trachea*, p. 144. London, 1837; South, *Chelius's Surgery*, Am. ed., vol. iii. p. 116, cited by Gross (op. cit., p. 325); Albers, *Arch. f. klin. Chir.*, Bd. viii. S. 177; Waters, *Brit. Med. Jour.*, February 15, 1868, p. 141; Masing, *St. Petersburg. med. Ztsch.*, H. 7, 1869—four years' detention; Boston *Med. and Surg. Jour.*, February 23, 1871, p. 128; Buck, *Trans. New York Acad. Med.*, 1870; Pick, *Trans. Path. Soc. Lond.*, 1870, p. 416; Ogle, *Med. Times and Gaz.*, November 5, 1870, p. 531; Holthouse, *Lancet*, January 27, 1872, p. 113; Ogle and Lee, *Lancet*, January 20, 1872, p. 81; *Med. Times and Gaz.*, September 21, 1872, p. 324; Hulke, *Lancet*, December 2, 1876, p. 785; Davy, *Brit. Med. Jour.*, July 8, 1876, p. 45; Burrow, *Berliner klin. Woch.*, No. 36. 1876; Thornton, *On Tracheotomy*, p. 36; Howse, *Lancet*, April 17, 1877.

¹⁷ Ruehle, *Die Kehlkopferkrankheiten*, S. 13. Berlin, 1861; Cohen, op. cit., p. 615; Agnew, op. cit., vol. iii. p. 45.

¹⁸ *Mém. de l'Acad. de Chir.*, t. v. p. 521.

¹⁹ *Revue mensuelle de Laryngologie*, etc., Octobre, 1881, p. 395.

²⁰ *Archives of Laryngology*, January 1, 1881, p. 62.

substances, but cases are known of penetration into the trachea of a foreign body from the œsophagus,¹ of a necrosed portion of the sternum,² of diseased bronchial glands,³ of pulmonary abscesses,⁴ of the contents of tuberculous cavities,⁵ of purulent pleural effusions,⁶ and of blood from pulmonary hemorrhages and aneurisms; cases are also known of ulceration into a bronchus⁷ of a bronchial gland, of escape of food from an œsophago-tracheal perforation,⁸ and of foreign bodies introduced by wound or disease into the thoracic cavities—including bullets, clothing, fragments of bone, fragments of a watch-movement, and pieces of glass.⁹

Many cases of foreign body in the air-passage occur in children having their playthings in their mouths. Many of these accidents take place while the individual is drinking, laughing, coughing, or talking. In another group of cases, the sudden inspiration which drives the substance into the air-tube is produced by a startling blow, a slap on the back, or even by tickling the neck.¹⁰ An experimental effort to sound a whistle by an inspiratory effort, has driven the loose reed into the left bronchus.¹¹ Suction sometimes detaches the mouth-piece from a feeding-bottle, and draws it into the air-passage.¹² A curious case has been recorded in the daily papers, of suffocation from a kernel of corn, driven into the windpipe of a man by the cough of a feeding horse.¹³ The variety of objects which produce the accident seems endless,¹⁴ embracing anything from a bean or a grain of corn—which, according to the researches of Weist,¹⁵ is the most frequent object in America—to a toy locomotive¹⁶ or the larynx of a goose.¹⁷

The subjoined classification by Poulet,¹⁸ based on Bourdillat's statistics, which include more than three hundred cases, shows concisely the variety of substances which have given occasion to the accident. Some additions have been made towards completing the list:—

¹ Vigla, Bégis, and others (Guyon, Dict. Encycl. des Sci. Méd., art. Larynx, pp. 705, 706; cited by Durham and by Poulet); Goll, Centralbl. f. Chir. No. 3, 1879; Castle.

² Bérard, Thèse de Paris, 1840; cited by Guyon and by Poulet.

³ Kjerner, Hygiea; Nordiskt med. Ark., VI., No. 1; New York Med. Jour., August, 1875, p. 206—a fatal case; Goodhart, Brit. Med. Jour., April 12, 1879, p. 542.

⁴ Canada Jour. Med. Sci., July, 1882, p. 238—a fatal case.

⁵ Geoghegan, Vigla; cited by Guyon (loc. cit.) and by Poulet (op. cit., p. 11)—fatal cases.

⁶ Canada Jour. Med. Sci., July, 1882, p. 238.

⁷ Edwards, Med.-Chir. Trans., vol. xxxvi.; cited by Durham, by Poulet, and by Mackenzie (op. cit.). The detached gland became impacted in the rima glottidis, having been expelled from the bronchus up the trachea during violent exertion.

⁸ Castle, Medical News, March 15, 1884, p. 300.

⁹ Poulet, op. cit., p. 22.

¹⁰ Benoit; cited by Guyon and by Poulet.

¹¹ Aronsohn, loc. cit.; cited by Poulet.

¹² Bordley, Am. Jour. Med. Sci., January, 1877, p. 271; Med. Times and Gaz., March 18, 1882, p. 295.

¹³ Chicago Times; and Philadelphia Times, December 28, 1879.

¹⁴ See Gross, Foreign Bodies in the Air-passages. Philadelphia, 1854; Poulet, Treatise on Foreign Bodies, vol. ii. New York, 1880.

¹⁵ Weist, Trans. American Surgical Association, vol. i. Philadelphia, 1883.

¹⁶ Johnston, Archives of Clinical Surgery, December, 1876 (illustrated).

¹⁷ Burow, Casper's Woch.; Brit. and For. Med.-Chir. Rev., 1850; London Medical Gazette, 1850, cited by Gross (op. cit., p. 35).

¹⁸ Op. cit., p. 22.

Inanimate,	Inorganic,	Solid,	Regular,	{ Beads; needles; coins and medals; buttons and button-moulds; bullets; pebbles.
			Irregular,	{ Surgical instruments; bullets; stones; toilet, shawl, and safety pins; fish-hooks; dress-hooks; pens; puff-darts; slate-pencils and lead-pencils; spikes, nails, and tacks; toys; artificial teeth, with and without blocks, pivots, and plates.
	Organic,	Hollow,		{ Rings; beads; tracheotomy-tubes; hypodermic needle; pencil-cases; whistles; mouth-pieces; pipe-bowls and pipe-stems.
			Regular,	{ Pills; beans; peas; grains of corn and coffee; apple, melon, raisin, pumpkin, and other seeds; acorns; stones of the apricot, cherry, date, plum and prune, tamarind, and other fruits.
Animate,	Organic,	Solid,		{ Pieces of rubber; fragments of nuts; nut-shells; pieces of fruit, meat, and vegetables; masticated food; bones of quadrupeds, fish, and fowls; lobster claws; muscle, oyster, and clam shells; spikes of oats; ears of rye, wheat, and barley; cockle, beech-nut, and other burrs; blades of grass; leaves, wood, and bark; teeth; feathers; sponges; matches; fiddle-pegs; sealing-wax; brushes; charcoal; corks; linen and cotton cloth and thread; yarn and wool; blood-clots; detached cartilages, bronchial glands, or other tissues.
			Irregular,	{ Pierced fruit-stones; quills, goose's larynx; rings of bone; rubber mouth-pieces and tubing.
		Hollow,		{ Worms; flies; leeches; hydatids; oysters; fish; bugs.

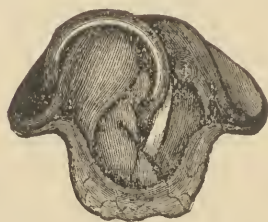
The majority of these substances are hard, and not likely to undergo change of size after impaction. Animal and vegetable substances, such as morsels of meat, beans, seeds, etc., may imbibe moisture and augment in size after incarceration. When retained for long periods, the foreign body may become incrustated with desiccated mucus and calcareous matter. Gross¹ mentions an instance, quoted from the *Ephemerides*, in which a concretion was formed as large as a nutmeg. The foreign body is usually single, but cases have been

¹ Op. cit., p. 38.

narrated in which from two to six substances, similar or diverse, have entered, either simultaneously or successively.¹

In some instances, the foreign body may be partly within the air-passage and partly without, as in the interesting case observed by Lefferts,² in which a brass ring had remained imbedded in the tissues of the larynx for four years, straddling the aryteno-epiglottic fold and ventricular band. (Fig. 1119.)

Fig. 1119.



Brass ring straddling the larynx. (Lefferts.)

Fig. 1120.



Obstruction of larynx by a piece of boiled beef. (Poulet.)

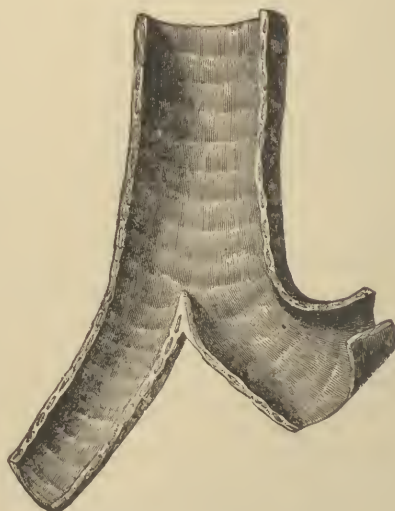
The foreign body may remain loosely imprisoned within the air-passage, or it may become impacted somewhere in the larynx (Fig. 1120), in the trachea (Fig. 1121), or in a bronchus. According to Bourdillat's statistics,³ of 156

Fig. 1121.



Obstruction of trachea by pancake. (Poulet.)

Fig. 1122.



Bifurcation of trachea. (Durham.)

instances of impaction, 80 took place in the trachea, 35 in the larynx, 26 in the right bronchus, and 15 in the left bronchus. The arrest of the foreign

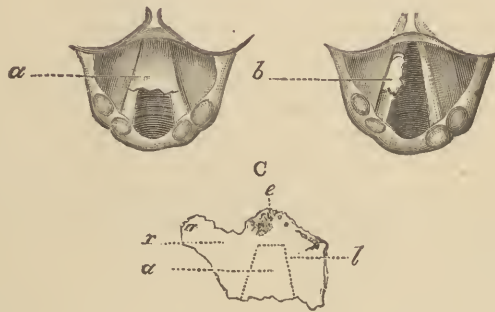
¹ Gross, op. cit., pp. 37, 38.

² Medical Record, December 15, 1874.

³ Gaz. Méd., 1861, p. 135; cited by Durham and by Mackenzie.

body takes place in the right primary bronchus much the more frequently, because, as indicated by Gross,¹ the septum at the bifurcation is to the left side, and because the right bronchus is the more capacious (Fig. 1122). In some instances a foreign body has become arrested in each primary bronchus. In some it becomes arrested in one of the smaller bronchi.² If arrested in the larynx, it may become lodged in one or both ventricles³ (Fig. 1123), or may become impacted between the vocal bands.

Fig. 1123.



Bone imprisoned in the ventricle of the larynx. (Mackenzie.)

A remarkable case of impaction in the posterior wall of the trachea, detected ten months after tracheotomy and the necessary retention of the canula, has been recorded by Voltolini,⁴ an anterior concavity in the foreign body having permitted the passage of the canula, although it impeded respiration whenever the canula was withdrawn. A cleansing rod, allowed to slip through a tracheotomy wound, was detected by aid of a tracheal mirror,⁵ and extracted with forceps during cough.

Occasionally a sharp foreign body in the larynx is forced through the tissues, soft and hard, to the exterior, whence it may be removed by integumentary incision;⁶ even the head of a pin has been known to penetrate the crico-thyroid membrane in this way.⁷

Occasion has already occurred (p. 231) to notice a case in which the point of a dart penetrated the carotid artery, and produced fatal hemorrhage.

Sharp-pointed substances, such as needles and pins, sometimes become impacted in the tissues of the larynx without directly interesting the lumen of the air-passage. Thus a case has been recorded by Wheeler,⁸ in which a threaded needle pierced an arytenoid cartilage; laryngoscopic inspection showing it to be fixed obliquely by the eye into the left palato-pharyngeal fold, and by the point into the arytenoid cartilage. Other efforts at extraction failing, pharyngotomy was performed and the needle extracted. A somewhat similar but still more remarkable case has been reported by Semon,⁹

¹ Op. cit., p. 46.

² Forbes, Med.-Chir. Trans., vol. xxxiii. p. 1; cited by Gross.

³ Mackenzie, Trans. Path. Soc. Lond., vol. xviii., p. 27, and Diseases of the Throat and Nose, etc., vol. i. p. 417.

⁴ Berlin. klin. Woch., 8 Februar, 1875. ⁵ Schmidt, Arch. f. klin. Chir., Bd. xviii. S. 1.

⁶ Wharton, Med. News, November 17, 1883, p. 541.

⁷ Coomes, Med. and Surg. Rep., March 22, 1884, p. 363.

⁸ Med. Press and Circular, April 22, 1875; cited by Poulet (op. cit., vol. ii. p. 80).

⁹ Trans. Clin. Soc. Lond., vol. xvi.; Reprint, London, 1883.

in which, with the aid of the laryngoscope, he removed a pin which for thirteen months had transfixed the left arytenoid cartilage and aryteno-epiglottic fold.

Symptoms of Foreign Bodies in the Air-Passages.—The usual symptoms are a sudden paroxysm of pain, cough, sense of suffocation, and spasm of the larynx. The graphic description of a severe initial paroxysm given by Prof. Gross,¹ includes all the phenomena of impending suffocative apnoea: that is, surprise, gasping respiration, violent coughing, distressing cries, partial loss of consciousness, lividity of countenance, projection of the eyeballs, contortion of the body, external manipulation of the throat, exit of frothy mucus and even of blood from the mouth and nose, emesis, and involuntary discharge of feces and urine. The initial paroxysm may terminate fatally, or may pass off after lasting from a few seconds to several minutes, or even several hours, should the foreign body be arrested in the larynx. Subsequent paroxysms occur at intervals of minutes, hours, or days, varying with the nature of the foreign body, its location, and the constitutional proclivities of the individual. The same circumstances determine whether, during the intervals, respiration shall remain tranquil or be disturbed, cough be slight or severe, and the voice be natural or changed.

In many instances the symptoms are slight from the beginning. After the violent, initial paroxysm has subsided, they may be so slight as to furnish no special subjective manifestation whatever, even though the foreign body be deeply impacted in the larynx.² False security may be induced in this way, and a sudden change of the intruder's locality may suddenly threaten suffocation.³

Traumatism may ensue from angular and irregular bodies, and thus progressive inflammatory symptoms—cough, hoarseness and dyspnoea, with insomnia and anxiety—may become superadded to those already existing. These secondary symptoms are sometimes prolonged after the removal of the foreign body, continuing until the inflammatory complications and sequelæ have subsided. Should the position of the foreign body occlude the œsophagus, dysphagia may become added to the earlier symptoms, and marasmus to the later ones. Long-continued symptoms of obscure bronchial and pulmonary disease are sometimes indicative of the prolonged sojourn of an unsuspected or forgotten foreign body.⁴ Hæmoptysis, dyspnoea, pyrexia, cough and expectoration, attributed to pulmonary tuberculosis, sometimes cease at once on expulsion of a foreign body from the air-passages.⁵

Diagnosis.—There is usually some history indicative of the lesion. In its absence, the suddenness of the symptoms may establish the diagnosis. As noted by Delasiauvé,⁶ the diagnosis is difficult in the cases of epileptics. When the symptoms are slight and the history concealed, the case may be mistaken for one of laryngitis. A foreign body in the pharynx or œsophagus, if it occlude the air-passage or compress it, will give rise to most of the subjective and objective phenomena of a foreign body in that part. Discrimination is effected by digital exploration, and by the use of the bougie

¹ Op. cit., p. 71.

² Whistler, *Lancet*, December 2, 1876, p. 779 (illustrated)—a bone impacted in the larynx for five weeks.

³ Porter, *Dublin Med. Press*, February 9, 1859; cited by Mackenzie.

⁴ Moore, Goodhart, MacLagan, Begbie, and Sharkey (*Lancet*, New York ed., February, 1883, p. 147); Coupland, *Lancet*, May 31, 1884, p. 984.—In this case a diagnosis had been made of pleurisy at the left base.

⁵ Laborde, *Gaz. Méd.*, No. 48, 1868, p. 701; Cohen, *Trans. Path. Soc. Phila.*, vol. iv. p. 148.

⁶ Poulet, op. cit., vol. ii. p. 17.

or probe. A bougie with a metallic tip will give a click, as it strikes the object.

Laryngoscopic inspection will usually reveal the foreign body, if present in the larynx, and sometimes if in the trachea.¹ In children an anæsthetic may be used, and the jaws may then be separated, the tongue held forward, and the laryngoscopic inspection attempted—sometimes with success, usually without it. If symptoms of suffocation be urgent, tracheotomy should be performed before the inspection is made. Macnamara² saved a life in this way by tracheotomy, recognized a large piece of fat bacon laryngoscopically, and removed it.

Auscultation of the trachea will detect a loose body there. Auscultation of the lungs will detect impaction in a bronchus. Obstruction of the left bronchus usually produces absence of respiration over the entire lung of that side, but occlusion of the right bronchus usually produces absence of respiration over the lower lobe of that side only, the division of the bronchus taking place much nearer the bifurcation, and the foreign body rarely lodging above the point of division.

In deciding between the presence of a foreign body and disease, it is maintained that the increased effort in respiration in the case of a foreign body, as contrasted with the increased frequency in disease, will suffice for the discrimination.³

Prognosis.—The prognosis is serious. Although foreign bodies sometimes remain for years without producing much apparent injury,⁴ their retention usually entails more or less of the following results: traumatic inflammation of the air-passage—which may be followed by œdema of the larynx, abscess, ulceration, gangrene, and necrosis—pneumonia, pulmonary abscess, pleuritis, pericarditis, hepatitis, or œsophagitis. On the strength of an autopsy in one of his own cases, Ingals⁵ calls attention to the likelihood of heart-clot occurring as a result of obstructed respiration. Furthermore, fatal inflammation has resulted although the foreign body has been expelled spontaneously. In view of these facts it seems proper to remove the foreign body by surgical procedure if there is any likelihood of success.

Weist,⁶ in an analysis of 1000 cases, gives 460 recoveries among 599 patients not operated on, or 76.79 per cent., against 245 recoveries among 338 operated upon, or 72.48 per cent. Much, however, depends upon the character of the cases. It is to be presumed that, as the rule, the severest cases have been treated by operation, and that the mildest ones have been treated expectantly. Should this have been the case, the recoveries would have been far more numerous had there been a greater proportion of operations. Dr. W. J. Smith⁷ adds the statistics of Gross and Durham to those of Weist, and reverses his result; 283 deaths among 955 patients not operated upon, or 29.78 per cent., and 178 deaths among 719 operated upon, or 24.75 per cent.—the entire proportion being one death in 3.5 of the unoperated cases, and 1 in 4 of the operated. Durham's⁸ statistics alone give a much better showing for

¹ Major, of Montreal, detected a tooth and plate at the bifurcation. *Archives of Laryngology*, October, 1882, p. 351.

² *Brit. Med. Jour.*, May 30, 1874, p. 714.

³ Parke, *Med. Times and Gazette*, April 16, 1881, p. 429.

⁴ Cameron, *Liverpool Med. and Surg. Rep.*, October, 1870 (penny in larynx six years, seen laryngoscopically and removed with forceps); Cohen, *op. cit.*, pp. 617, 619, and *Trans. Path. Soc. Phila.*; Semon, *Brit. Med. Jour.*, April 21, 1883, p. 770. (A pin remained impacted in the larynx for thirteen months.)

⁵ *Independent Practitioner*, June, 1882, p. 364.

⁶ *Op. cit.*

⁷ *London Med. Record*, June 16, 1884, p. 238.

⁸ *Op. cit.*, 3d ed., vol. i. p. 765.

the operation, 260 patients having recovered out of 338 operated upon, and only 176 out of 298 not subjected to operation. In a later table Durham¹ analyzes 212 cases of tracheotomy for foreign body, with 157 recoveries.

When retained for a long time the foreign body may become encysted,² even in the lung substance.³ Much more frequently it excites ulcerative inflammation, laryngitis, bronchitis, or pneumonitis, as may be, with gradual exhaustion from disease of the larynx, trachea, or lungs. Extreme tolerance is occasionally exhibited, however, as in a case reported by Franks,⁴ in which a chicken bone measuring $1\frac{3}{8}$ inches, by $1\frac{1}{8}$ inches, by $1\frac{1}{16}$ inches, remained impacted above the vocal bands for twenty-three days.

Watson⁵ cites an instance in which a piece of gold was lodged for years in one of the ventricles of the larynx, without distressing circumstances, and Gross⁶ one in which a piece of bone was expelled in coughing after sixty years' retention.⁷ When retained for some time, substances are not infrequently expelled spontaneously in fragments. Nuts, beans, coffee grains, and pills are ejected in this way, and even a hypodermic needle, inhaled by a physician who had placed it between his lips, was expelled in two pieces, after thirteen days' retention.⁸

The period at which spontaneous expulsion takes place, varies with the individuality of the case. In 136 cases of recovery summarized by Durham, expulsion took place immediately, or in less than twenty-four hours, in 6; in from one to eight days in 12; in from eight to thirty days in 19; in from thirty days to one year in 68; and in from one to seventeen years in 31.

In the great majority of instances, spontaneous expulsion is followed by recovery from all sequelæ, even though the expulsion have been delayed months, or even years.⁹ Nevertheless, after the substance has remained in the air-passage for a number of months, death often follows spontaneous expulsion¹⁰—sometimes within a few days, and sometimes after prolonged suffering, extending over many months.

Treatment of Foreign Bodies in the Air-passages.—The spontaneous expulsion of foreign bodies by coughing, early suggested the administration of emetics and sternutories¹¹ for the purpose of exciting expulsive expiratory efforts. Theoretically there seems to be a risk run of producing sudden impaction at the chink of the glottis, as alluded to by all writers on the subject; but any recorded instance of life lost in this manner has escaped my research. The same remark is applicable to the apparently equally condemnable plan of inverting the body and slapping the patient on the back or on the chest. The generally received surgical opinion is that these measures, though often successful, are unjustifiable unless a preliminary incision has been made into the air-passage, or unless the surgeon is fully prepared to perform immediate tracheotomy on the occurrence of urgent symptoms. To favor expulsion by the method of inversion, the patient should be made to take a deep inspiration at the moment of inversion, and to follow this with a strong effort at expiration. At the beginning of the latter effort, a blow is to be given opposite the point at which the foreign body is believed to be lodged.

¹ Ibid., p. 770.

³ Durham op. cit., Am. ed., vol. i. p. 704.

⁴ Archives of Laryngology, October, 1882, p. 352.

⁵ Practice of Physic, 4th ed., vol. ii. p. 436; cited by Durham.

² Gross, op. cit., p. 47.

⁶ Op. cit., p. 172.

⁷ Bartlett, New York Journal of Medicine and the Collateral Sciences, vol. vi. p. 23. Ibid p. 172.

⁸ Sydney Jones, Lancet, August 7, 1880, p. 208.

⁹ Heckstetter's case, and others, cited by Gross (op. cit., pp. 117-173); Elsberg, Phila. Med. Times, July 29, 1882, p. 729; Faught, Medical News, Oct. 13, 1883, p. 205.

¹⁰ Gross, op. cit., pp. 173-182.

¹¹ Aetius, cited by Guyon (Bull. Gén de Thérap., 15 Janv., 1869, p. 15).

The smooth contour of pebbles, and the circular form of coins, whose weight and shape favor their obedience to the laws of gravity, favor their removal by the ingenious plan of Padley.¹ "A strong bench having been fixed with the legs of one end on a couch, and the other on the floor, the patient was made to sit on the upper part of it, with his knees flexed over the end. He was then directed to lie back upon the inclined plane thus formed, and, having done so, instantly raised himself up with the sixpence in his mouth. The supine position probably favored the exit of the coin, and the readiness with which, by his own effort—the knees acting as a fulcrum—he gained the upright position, would have saved him from the danger of spasm in the event of its non-expulsion."

Krishaber, having determined laryngoscopically the position of a metal-tag, turned a child over, inserted his finger into the larynx as a guide, and removed the substance with forceps.²

Should attempts at mechanical dislodgment by the methods described be deemed injudicious, or prove inefficient, there remain the methods of removal by extraction, sometimes performed by way of the natural orifice of the air-passages, and sometimes by way of an artificial incision from the exterior.

Extraction through the mouth may be performed under laryngoscopic inspection, or without it. In either case, whenever practicable, the position of the substance should be ascertained laryngoscopically before its withdrawal is attempted. Forceps and blunt hooks are the instruments usually employed in these manipulations. In many instances the ingenuity of the surgeon is taxed to devise some special instrument adapted to the case in hand. Thus Brandeis³ removed a thread from the larynx by means of a brush dipped in mucilage.

Extraction by way of the natural passages, although successfully performed at times under very adverse conditions, seems justifiable, as a rule, only when the foreign body is situated above the vocal bands. If the foreign body be below the glottis, this procedure may be entertained only when the substance is of such a character that it will not be apt to strike those structures and injure them, or provoke spasm. Injury to the vocal bands may entail permanent impairment of voice. The cases in which jagged bodies, such as impacted portions of dental plates, have been forcibly torn from the larynx, lacerating vocal bands and other tissues⁴ without permanently injuring the patient, should be regarded rather as lucky instances of the tolerance of the tissues, than as commendable evidences of the surgeon's skill. Small, slender, and regularly shaped substances, such as fish-hooks, needles, pins, coins, and leeches,⁵ have often been safely extracted under laryngoscopy. Brittle substances such as bones and nutshells, when not likely to be withdrawn in bulk without tearing the tissues, should be broken in the blades of forceps, and, if not spontaneously coughed out, may then be removed in fragments. As one of the most recent examples of what can be done laryngoscopically, I reproduce from Grazzi⁶ a sketch of the laryngoscopic image (Fig. 1124) of a coin impacted in the ventricles of the larynx, and a sketch of its appearance in the grasp of the slide-forceps (Fig. 1125) with which it was withdrawn.

When the impacted body is of such a contour as to prevent its ready

¹ Brit. Med. Jour., Nov. 6, 1878, p. 721.

² Annales des Maladies de l'Oreille, etc., 10 Mai, 1878.

³ American Practitioner, Nov. 1873, p. 317.

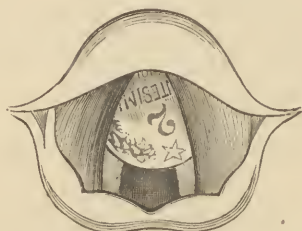
⁴ Oppenheimer, New York Med. Jour., Sept. 1879, p. 398.

⁵ R. de la Sota removed a leech from the uppermost ring of the trachea, with laryngeal forceps. El Anfiteatro Anatomico, No. 73, 1874; Archives of Laryngology, Jan. 1883, p. 17.

⁶ Bollettino delle Malattie dell' Orecchio, della Gola, e del Naso, 1884, No. 4.

extraction, it is far better practice to perform tracheotomy.¹ In some instances, tracheotomy having been performed, subsequent laryngoscopic manipulation may supersede the alternative of splitting the larynx; as in a case of bone impacted in the ventricles, under the conjoint care of Sir William Fergusson and Dr. Morell Mackenzie² (see Fig. 1123), in which, some

Fig. 1124.



Coin impacted in the ventricles of the larynx. (Grazzi.)

Fig. 1125.



Coin in grasp of forceps. (Grazzi.)

days after the tracheotomy, the bone was dislodged with a blunt hook and expelled in two pieces, one in the grasp of the hook, and the other by coughing after similar dislodgment, the day following. In other instances, the extraction may be accomplished safely after awaiting subsidence of the local inflammation, as in a case in which a lamella of bone, measuring nearly one inch by three-fourths of an inch, was removed by Whistler³ from below the vocal bands, six weeks after it had become firmly imbedded in the laryngeal

Fig. 1126.



Cusco's lever-bladed laryngeal forceps.

tissues. These manipulations are performed with curved laryngeal forceps, one of the best of which is the lever-bladed forceps devised by Cusco. (Fig. 1126.)

Voltolini⁴ has suggested the use of a powerful magnet, applied externally, to lift a needle, tack, or other object susceptible to magnetic attraction, out of the air-passage into the pharynx, or to fix it at a point accessible to laryngeal forceps, or to a magnetized probe. It is quite possible that a magnetic probe or pair of forceps introduced into the air-passage, whether laryngoscopically or through an external incision, might draw towards it any small body of this kind.

¹ For cases in point, see Schmidt, *Arch. f. klin. Chir.*, Bd. xvi. H. 1, S. 186; Cohen, *op. cit.*, p. 620; R. de la Sota, *Archives of Laryngology*, Jan. 1883, p. 13.

² *Op. cit.*, p. 417.

³ *Lancet*, Dec. 2, 1876; cited by Mackenzie (*op. cit.*, p. 416).

⁴ Personal communication; and *Trans. International Medical Congress of 1881*, vol. iii. p. 334.

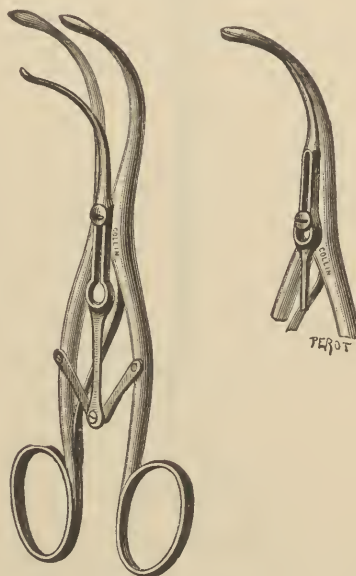
In the great majority of cases, however, it will be found necessary to make an artificial opening into the air-passage from the exterior.¹ The point at which the incision is to be made will depend on the subject to be operated upon, and on the character and position of the foreign body. If a large or irregularly shaped substance be impacted in the larynx, it may become necessary to divide the thyroid cartilage (*thyroidotomy*) to get proper access to it. Smaller and smooth objects may be reached through wounds in the crico-thyroid membrane only (*crico-thyroid laryngotomy*). In cases of foreign body in the trachea or bronchi of the adult, and almost always in children, tracheotomy is preferable to crico-thyroid laryngotomy, as affording greater freedom of manipulation for dislodgment. The incision should be about one inch long in the child, and an inch and a quarter in the adult. Very often the foreign body is ejected through the wound the moment after the air-passage has been opened. Sometimes it is ejected through the mouth. Sometimes it is driven to the orifice of the wound, whence it may be extracted with forceps. Should the foreign body fail to appear, the patient is to be turned over so that succussion may be tried to dislodge it. This failing, the surgeon may blow strongly into the trachea, so that the air, thus compressed, may become more expulsive in the cough which follows.

Should all these methods fail, search must be made for the body. For this purpose it is customary to have the edges of the wound held apart by a special dilator—the two-bladed instrument of Trousseau (Fig. 1127), or the three-bladed one of Laborde (Fig. 1128), being held in position by an assis-

Fig. 1128.



Trousseau's dilator.



Laborde's dilator.

tant. Dress-hooks, or other bent hooks, attached to a tape or an elastic band, to go round the neck, will answer the purpose. The automatic retractor

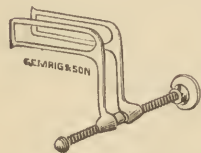
¹ According to Guyon (loc. cit.), first formally proposed in 1644, by Monavius, and first practised in the presence of Verduc (Pathol. de Chir., tome. ii. p. 849. Paris, 1710).

of Golding Bird¹ (Fig. 1129) is the best instrument that I have used or seen used for the purpose. When respiration is improved by the operation, the presumption follows that the foreign body is in the larynx, and that organ therefore should be explored first. The foreign substance can sometimes be pushed into the mouth by means of the exploring instrument. Annandale² recommends additional support from the mouth by introduction of the finger. Exploring and extracting instruments should be warmed before they are introduced into the air-passage, so as to diminish their liability to excite spasm; should this occur, the instrument should be maintained in position without using

any force, for the spasm usually ceases in a few moments.

The instrument employed will vary with the character and position of the foreign body, and with the resources of the surgeon. A long probe, bent at

Fig. 1129.



Golding-Bird's retractor.

Fig. 1130.



Gross's tracheal forceps.

Fig. 1131.



Cohen's tracheal forceps.

one end into a blunt hook, and a delicate pair of forceps, are perhaps the most useful instruments. Gross's flexible, German-silver tracheal forceps (Fig.

¹ Lancet, March 1, 1881, p. 407 (illustrated).

² Med. Times and Gaz., Feb. 27, 1875.

1130) are highly commended by most surgeons. A pair of shouldered forceps used by myself (Fig. 1131)—a combination of Gross's nasal polypus-forceps and Simrock's nasal dressing-forceps—seems to me both stronger and easier of manipulation. The instrument is first used as a sound to detect the foreign substance, and then the effort is made to seize it or dislodge it, as may be. For substances—such as nut-kernels, for example—impacted in a bronchus, a stout copper wire, bent into a short blunt hook, serves an admirable purpose. The forefinger is often available as a searcher or guide to instruments. The bifurcation of the trachea can usually be reached with it.¹

Efforts at extraction should not be too prolonged. It is better to keep the wound patent—by dilators, hooks, or stitches—and to repeat the efforts on the day following. A canula would be out of place if the foreign substance were below the wound, as it would impede the spontaneous expulsion which often follows the practice here recommended. Spontaneous expulsion after tracheotomy is often delayed until the inflammatory sequelæ have subsided. Thus, a pin-point dart was expelled from a bronchus sixteen days after the operation.² In removing substances from a bronchus, after tracheotomy, Annandale³ recommends a deep inspiration, and temporary occlusion of the wound until the deep expiration follows—a movement which often drives the body out. Many ingenious devices have been employed to meet special indications. Thus, in the removal of tracheotomy tubes, a wire is used, the end of which has been bent into a blunt hook to catch the edge of the tube. Davy⁴ placed a patient's head slightly lower than his heels, threaded the eye of a surgical probe for safety, hooked the probe at the other end and caught it on the edge of the outer tube, and thus extracted both tubes, which had been telescoped in the trachea to the extent of $3\frac{3}{8}$ inches. A pen-case was in the left bronchus; tracheotomy had been performed; Laidler⁵ passed a silver plummet, fifteen inches long, by the side of the foreign body, and moved it up and down, much after the manner of priming a pump. By this plan, aided by voluntary cough, the body was eventually coaxed to the orifice and extracted with forceps.

In cool weather, the air of the apartment occupied by the patient should be kept artificially warmed to about 70° F., and should be moistened by evaporation of hot water as long as the artificial opening is kept patulous. When it becomes desirable to close the wound, it is merely necessary to retain its cutaneous edges in apposition with adhesive strips.

Ordinary pharyngotomy has been performed by Wheeler⁶ to remove a needle impacted in an arytenoid cartilage, and sub-hyoidean pharyngotomy has been performed by Lefferts⁷ to remove a watch-ring imbedded in the aryteno-epiglottic fold and the ventricular band. Both these procedures, however, are unusual in the management of foreign bodies in the air-passages.

FISTULA OF THE LARYNX AND TRACHEA.

Fistulæ of the larynx and of the trachea occur as congenital defects, and as pathological perforations. The surgical laryngotomy or tracheotomy wound is a fistula likewise, but, being made on purpose, does not come into discussion here.

¹ Sands, cited by Buck (Trans. New York Academy of Medicine, 1870).

² Conner, Am. Jour. Med. Sci., October, 1877, p. 595.

³ Med. Times and Gaz., Feb. 27, 1875.

⁴ Brit. Med. Jour., October 27, 1877, p. 590.

⁵ Medical Press and Circular, April 22, 1875.

⁶ Brit. Med. Jour., July 8, 1876.

⁷ Medical Record, Dec. 15, 1874.

CONGENITAL FISTULA may be complete or incomplete. It is attributed¹ to defect in the normal closure, during foetal existence, of the third or fourth branchial fissure, or to defect in the union of the third or fourth branchial arch. In the former and more frequent instance, the external orifice, for the lesion is usually unilateral, will be located at the inner border of the sternomastoid muscle, or between its two heads, half an inch or more above the sterno-clavicular articulation. In the latter instance, the orifice is in the middle line, sometimes as high up as the cricoid cartilage. When the lesion is bilateral, in the first class of cases, the two integumentary orifices are usually symmetrically located. Ten instances of bilateral fistula out of a total of forty-six have been collated by Heusinger.² One instance has been reported of three external orifices arranged longitudinally.³

The integumentary opening is usually quite small, barely permeable with a lachrymal probe, sometimes admitting a bristle merely. The orifice is bulbous, often tumid, sometimes indurated, and usually congested. It becomes temporarily sealed from time to time by desiccated mucus. The fistulous track is very minute in calibre, often impassable by the most delicate probe. It is lined with mucous membrane, sometimes quite discernible at the external orifice, from which a drop or two of mucus or muco-pus exudes from time to time, or is pressed out by the patient at intervals for purposes of cleanliness. The internal orifice opens into the larynx much more frequently than into the trachea. Tracheal fistulae, for some indeterminate cause, have been noted almost solely in females.⁴ In incomplete fistula, there will be no integumentary opening unless an abscess is formed, the discharge of which, externally, converts the lesion into a complete fistula. Hence the history of a complete fistula usually begins with birth, or shortly thereafter, while the history of an incomplete fistula begins much later in life, dating from the appearance or rupture of the overlying abscess. Thus a case was observed in Langenbeck's clinic,⁵ of a child twelve years of age, in whom a tumor, probably an abscess, some two inches above the sternum, and in the median cervical region, had been opened with caustic several years previously; and a somewhat similar case, in a lady in her thirty-seventh year, has occurred in the practice of Dr. Young, of Florence, and Mr. Pugin Thornton,⁶ of London, the internal orifice, which was detected laryngoscopically, occupying the right ventricular band—a location indicative of an intricately circuitous track, probably due to abscess in two directions.

Symptoms.—The symptoms are a daily discharge of two or three drops of mucus or purulent mucus, from a minute pouting orifice in one of the localities mentioned; the expulsion of air-bubbles on forced expiration, in some instances; and the ability to draw air inward in exceptional cases. Abnormal voice has occasionally been noted. In a few examples of supposed incomplete fistula seen by myself,⁷ in young adults of both sexes, sudden emphysematous tumefaction occurred from time to time in the anterior cervical region, the tissues in one instance becoming pushed beyond the chin. At times, all this would occur within a few minutes; at times it would consume several hours. Though most frequent after exertion, or under emotional

¹ Foerster, *Die Missbildungen der Menschen*. Jena, 1861.

² Virchow's Archiv, Bd. xxxiii. S. 177.

³ Ascherson, *De fistulis colli congenitis*. Berlin, 1832; cited by Riegel and by Agnew.

⁴ Bardeleben, *Lehrbuch der Chirurgie und Operationslehre*, Vierte Ausgabe, Bd. iii. S. 445. 1864; cited by Riegel.

⁵ Fischer, Pitha und Billroth's Handbuch, Bd. iii. Abth. i. Lief iii.; cited by Riegel.

⁶ Archives of Laryngology, April, 1883, p. 127 (with laryngoscopic illustration of laryngeal orifice).

⁷ Op. cit., p. 598.

influences, sobbing, etc., the phenomenon was said to occur at other times without any appreciable exciting cause.

Diagnosis.—Occasionally, it is said, the internal orifice can be detected laryngoscopically, but the only exemplification at my immediate command is the case of Young and Thornton, above alluded to. When not so discernible without other aid, the opening can be detected, it is said, after the passage of a bright silver probe through the track, or after the injection of a colored liquid. Only exceptionally, however, can a probe be insinuated into the trachea. Of all the cases cited by Dzondi,¹ all of which, it may be mentioned, occurred in females, in one only had the probe been passed without doubt into the trachea. The expulsion of air-bubbles, on voluntary effort with nose and mouth closed,² is exceptionally an additional factor in diagnosis. The frequent absence of this physical sign allows the case to be confounded with one of pharyngeal fistula.

Prognosis.—The cure of a congenital fistula is always doubtful. Thornton cured his patient by electrolysis.

Treatment.—The methods employed comprise irritant injections with solutions of iodine, carbolic acid, nitric acid, and acid nitrate of mercury; cauterization with a probe dipped into nitric acid; cauterization with the galvanocautistic point, or with a red-hot copper wire passed through a small canula previously slid through, over a probe; electrolysis; and excision of the fistulous track. In a case of congenital fistula of the larynx, in a young gentleman upon whom I performed the latter operation, a fresh fistulous track formed subsequently, and opened in an adjoining spot; but it yielded much less secretion than the original one.

PATHOLOGICAL FISTULÆ are laryngeal much oftener than tracheal. They occur as the result of incompletely healed abscesses, and of incompletely cicatrized wounds and perforations. The abscesses follow perichondritis and chondritis, terminating in caries and necrosis, whether from typhosis, tuberculosis,³ syphilis,⁴ lupus,⁵ morbid growth,⁶ foreign body in the air-passage or œsophagus, or external compression by an enlarged gland or morbid growth. The wounds are usually suicidal, sometimes homicidal, sometimes accidental, and occasionally surgical. Fistulæ after suicidal wounds are not infrequently due to interference with the dressings by the patient's own hands. Perichondritis, chondritis, caries and necrosis, sometimes form the pathological sequence, as in fistula from disease.

Connective tissue hyperplasias often occur in the softer tissues, and thus stricture of the larynx may coexist.

When resulting from intra-laryngeal neoplasm, the fistula usually occupies the cricothyroid membrane, which undergoes absorption in some instances, and ulcerative perforation in others. When the result of a wound, it is due to incomplete closure, as in suicidal incised wounds, or to extensive ulceration and necrosis, as in gunshot wounds. Under these circumstances, the orifice is sometimes very large, as in the case mentioned on page 235, and it

¹ De fistulis tracheæ congenitis. Halæ, 1829; cited by Riegel.

² Ammon, Die angeborenen chirurgischen Krankheiten der Menschen. Berlin, 1842; cited by Riegel.

³ Krieg, Wiener medizinische Zeitung, 1880; cited by R. de la Sota (Rev. Méd. de Sevilla, tomo iii. No. 33. 1883.)

⁴ Lefferts, Archives of Laryngology, Jan. 1883, p. 53; R. de la Sota, loc. cit. (From a suppurating gunma in the infra-hyoid region.)

⁵ E. H. Bennett, Brit. Med. Jour., Feb. 25, 1882, p. 273; continued in Dub. Jour. Med. Sci., July, 1882, p. 81; and private confirmatory note, Nov. 10, 1882.

⁶ R. de la Sota (Archives of Medicine, April, 1884, No. 2) reports a case originating in a pre-thyroidal cyst.

is very irregular in outline. Occasionally, a tracheal fistula remains from incomplete closure of a tracheotomy wound.¹

Symptoms.—The symptoms are escape of air, saliva, mucus, pus, and *débris* from the external orifice. Decomposition of the discharges takes place in consequence of their free exposure to the atmosphere, and the stench becomes horribly fetid in some instances. The voice is considerably altered, and not at all audible in a fissure of any size below the vocal bands, unless the orifice be occluded with the finger or with a compress. Cough is harassing. Dysphagia exists in some instances. Emaciation is sometimes extreme. Symptoms of septic poisoning become superadded in some cases, especially in those which are about to terminate fatally.

Diagnosis.—The external communication with the interior of the air-passages is so obvious on inspection that a mistake in diagnosis is hardly possible. Sometimes the internal orifice can be detected laryngoscopically, even when quite minute, especially when a probe can be passed through the track, as in R. de la Sota's case, above referred to.

Prognosis.—The probability of successful obliteration is dependent upon the nature of the disease or injury by which the fistula has been produced, the size of the orifice in the air-tube, and the preservation of sufficient surrounding integument to admit of its closure by adhesive inflammation or by plastic operation. In Bennett's case, due to ulceration by lupus, the fistula closed completely under the inflammatory process excited by an intercurrent erysipelas, which commenced at the fistula, and extended over the neck, face, and upper part of the body. A large fistula cannot be cured, but the orifice may be occluded with a compress when the patient wishes to talk, and may be kept hidden from sight by some simple apparatus worn around the neck. Life may be prolonged for years under such conditions, as in a case of tracheal fistula known to Van Swieten, and reported by Boyet,² and in the case of laryngeal fistula mentioned on page 235.

Treatment.—In small fistulæ, the borders of which are covered by integument, it has been recommended by Dieffenbach,³ to touch the edges with tincture of cantharides, and then draw them together by sutures, which are allowed to remain for six or eight days. When the interior of the trachea is exposed, the same surgeon excises a small wedge of integument above and below, detaching the edges sufficiently to secure apposition without tension, and then inserts four or more points of twisted suture. If the edges are indurated, he makes a long vertical incision on each side, and detaches the flaps from the subjacent tissues. Watson⁴ recommends removing a circular section of integument from the circumference of the opening, and uniting the wound with twisted sutures. Le Fort⁵ in one case freshened the edges of the orifice, applied semi-elliptic flaps of integument, taken from above and below, and secured them with stitches, which were removed on the sixth day. A small opening, which remained from the giving way of the middle stitch, yielded to cauterizations with nitrate of silver.

In a large fistula from suicidal wound, a friend succeeded in closing the gap, at my suggestion, by adjusting a flap, cutaneous side inward, cutting the exuberant portion loose after adhesion had taken place, and replacing it upon the proximal portion of the gap in the integument—the distal portion having been united by twisted suture at the initial operation. It is a matter of regret that my notebooks fail to trace this device to its originator.

¹ For a case reported after laryngotomy for diphtheria, see Dupuis, *Deutsche Zeitschrift für Chirurgie*, 25 März, 1875; Lefferts's Reports, *New York Med. Jour.*, July, 1875, p. 84.

² Cited by Cruveilhier (*Traité d'Anatomie Pathologique*, t. ii. p. 560. Paris, 1852).

³ *Die operative Chirurgie*, Bd. i. S. 508.

⁴ *Edinburgh Med. Jour.*, April, 1844.

⁵ *Dictionnaire de Médecine et de Chirurgie Pratiques*. Article *Larynx*, p. 287. Paris, 1875.

Lefferts¹ succeeded in closing a syphilitic fistula of the larynx by performing a tracheotomy for coexisting stenosis in such a manner so as to include the fistulous opening, scraping the edges clean, treating the disease which produced the lesion, and then removing the canula.

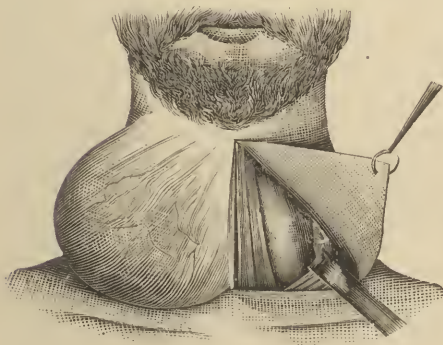
Agnew,² in a case remaining after suicidal wound, cut a long rectangular flap of skin, turned it upon itself so as to be able to adapt the distal raw surface to the freshened edges of the gap, and thus plugged the orifice.

Large fistulæ do not appear to be amenable to obliterative treatment. They are to be covered with compresses or pads, concealed beneath the collar and neck-cloth.

STRICTURE OF THE LARYNX AND TRACHEA.

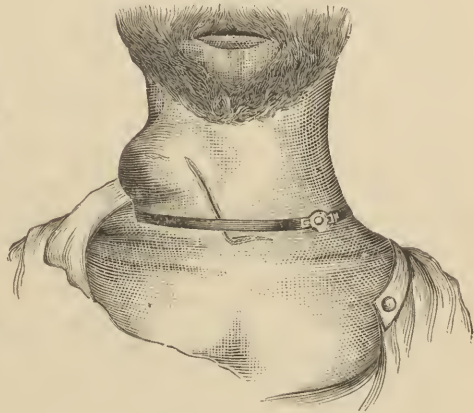
Stricture of the larynx and trachea, technically known as stenosis, is either extrinsic or intrinsic. Sometimes the two conditions coexist.³ One organ or both may be implicated; and there may be more than one point of constriction, whether in the larynx or in the trachea. Extrinsic stricture is due to involution of the walls by pressure outside of the aërial canal—*compression-stenosis*—whether produced by foreign body, by localized emphysema, by cervical abscess, by enlarged thyroid, thymus, or cervical or bronchial lymphatic

Fig. 1132.



Compression and deflection of trachea by cervical tumor; sterno-mastoid retracted to show trachea $2\frac{1}{4}$ inches to left of median line, and $2\frac{1}{4}$ inches below integument. (Janney.)

Fig. 1133.



Canula in position three months after operation; recession of tumor and trachea towards median line. (Janney.)

glands, by cicatricial tissue, by morbid growth—cervical, œsophageal, or mediastinal—by aneurism, or by disease of the vertebræ, sternum, or clavicle. In cases of cervical tumor or abscess, the trachea may be pushed far out of line, as in a remarkable case, as yet unpublished (Figs. 1132 and 1133), under the care of Dr. Janney, of Philadelphia.

Intrinsic stricture—*occlusion-stenosis*—is due to congenital malformation or

¹ Loc. cit., p. 56.

² Med. and Surg. Rep., April, 1873, p. 316.

³ For example, see Ashhurst's case of Fistula. Med. and Surg. Rep., August 14, 1880, p. 142.

disease,¹ to foreign body or neoplasm within the canal, or to disease in its walls, to paralysis of the dilating muscles of the larynx, to spasm of its constricting muscles, or even to spasm of the trachea.² Intrinsic stricture may be due to temporary causes, such as inflammatory tumefaction, hemorrhagic effusion, œdema, pseudomembrane, benignant neoplasm, foreign body, spasm, and paralysis; or it may be due to permanent causes, such as intussusception of the trachea,³ longitudinal involution,⁴ hypertrophic or hyperplastic tumefaction, neoplasms clinically or histologically malignant, granulation neoplasms,⁵ organized membrane, inflammatory adhesions between adjacent structures⁶—such as vocal bands, ventricular bands, arytenoid cartilages, epiglottis, and pharynx—or cicatricial contraction following ulcerative processes, whether originally syphilitic or tuberculous, traumatic, the results of scalds and cauterizations,⁷ or occurring in smallpox, measles,⁸ scarlatina, diphtheria,⁹ or enteric fever.¹⁰ In cases of suicidal wound, the larynx may become occluded by a cutaneo-pharyngeal membranous partition.¹¹

The extent to which the calibre of the trachea is diminished in extrinsic stricture, varies between extreme limits. When the pressure is great, it may become reduced to a mere slit-like passage, the direction of which, determined by the direction of the compression, although most frequently transverse, may even be antero-posterior.¹² As a rule, the only pathological condition noted has been the involution of the tract, without structural change. Hypertrophy of the mucous glands and submucous connective tissue has frequently been found, however, in cases of compression by goitre,¹³ and perhaps under other similar conditions. Ossification of the laryngeal cartilages and extensive amyloid and calcareous degeneration of the tracheal walls have been noted occasionally,¹⁴ while attenuation and atrophy of the cartilaginous rings are not uncommon, and even complete absorption may take place, so that the tube becomes perforated.

In intrinsic stricture, the amount of constriction varies between the extreme limits imaginable. Complete obliteration of the canal takes place in some instances, life being saved by tracheotomy below the seat of stricture. The tightest intra-laryngeal strictures are observed chiefly in cases of syphilis, and in cases of wounds, suicidal and gunshot. The most frequent cause in America is local syphilitic disease, and the next, suicidal wound; but enteric

¹ Elsberg, Trans. International Medical Congress, vol. iii. London, 1881; DeBlois, Cases of congenital membranous web, New York Medical Journal, 1884; Steavenson, Case of cyst in crico-thyroid membrane, St. Bartholomew's Hospital Reports, vol. xviii. p. 330.

² Allison, On Morbid Throat in Relation to Consumption, p. 12. London, 1869; Schnitzler, Wiener Klinik., Jan. 1877.

³ Lee, Med. Times and Gaz., May, 1874, p. 548. (In this case the posterior portion of the upper tracheal ring approximated the cricoid cartilage to within one-quarter of an inch.) Long, Memorabilien, 11 Jan. 1876. (In this case it was found, after death, that the third tracheal ring was forced inside the second when the head was flexed.)

⁴ Carrié, Thèse. (In this case, in which sudden death, on removal of the canula, had been attributed to granulation neoplasm, there was found longitudinal involution, the result of approximation of the posterior extremities of the severed cartilages.)

⁵ Bouchut, Gaz. des Hôp., No. 35. 1874. (A fatal case after tracheotomy.)

⁶ This occurs sometimes after tracheotomy. Mackenzie, Am. Jour. Med. Sci., April, 1870, p. 487.

⁷ Stenosis of Larynx from Sulphuric Acid. Fieber, Allg. Wien. med. Ztg., No. 8, 1874.

⁸ G. Hunter Mackenzie, Edinb. Med. Jour., Oct. 1883; Med. and Surg. Rep., Oct. 27, 1883, p. 471. (Stenosis of Larynx.)

⁹ Complete laryngeal stenosis has been observed by Stoerk.

¹⁰ Kieselbach has reported a case with stenosis of both larynx and trachea. Deutsch Ztg. f. Chir., Bd. xiii. S. 554.

¹¹ Reynaud, Journ. Univ. et Hebdom., tome iii. p. 201. 1831; Bourgot, Thèse de Montpellier, 1844.

¹² Balser, Virchow's Archiv, Bd. xci. H. 1.

¹³ Demme, Wurzburger med. Ztschrift, Bde. ii. und iii. 1861; cited by Riegel.

¹⁴ Balser, loc. cit.

fever¹ seems to be the most frequent cause on the continent of Europe. After suicidal wound, although the vocal bands may remain intact, the lower portion of the larynx may undergo complete funnel-shaped obliteration.² The tightest intra-tracheal strictures are produced by cicatrization of syphilitic ulcerations. Thus, in a case reported by Worthington,³ the calibre of the tube had become reduced to that of a crow-quill. In this case the cartilaginous rings below the seat of constriction, at the upper rings of the trachea, had undergone attenuation and dilatation, quite from the point of bifurcation. Intra-tracheal cicatricial stricture is most frequent just above the bifurcation, but it occurs at a higher level, as at the fourth and fifth rings,⁴ and not infrequently just below the cricoid cartilage.⁵ The depth of the stricture varies from a few lines to more than an inch.⁶ Gerhardt mentions four cases⁷ in which the entire surface of the tracheal wall was the seat of disease.

Symptoms.—The symptoms, though varying somewhat in detail, are similar, no matter where the constriction. The main symptom is inspiratory dyspnoea, whether constant or only developed on exertion. As the stenosis becomes greater, the dyspnoea increases, and the voluntary muscles of respiration are brought prominently into play. The inspiratory stridor gradually augments, in some instances merging into stridulous respiration in both phases, with recession of the soft parts during inspiration. The face becomes pale or livid in severe cases, the countenance expresses anxiety or dread, and the pulse becomes small and frequent. Sensations of oppression of the chest become a source of discomfort and of fear. Cough is not a necessary phenomenon, and presents itself independently of the stricture. Compression of a primitive bronchus, and especially of both bronchi, will produce symptoms identical with those of compression of the trachea. Certainty of differential diagnosis, then, depends upon recognition of the bifurcation in the laryngoscopic image. The symptoms are usually gradual when due to disease other than acute laryngitis; and they often present themselves suddenly when due to injury.

The usual phenomena of suffocative apnoea supervene, should the constriction become extreme. The voice is impaired in the majority of cases; but the character of the impairment depends upon the location of the constriction. It is faint and muffled in many cases of tracheal stricture, owing to the small amount of air passing. Deglutition may be impeded when the upper part of the larynx is involved.

Diagnosis.—The history of the case, the dyspnoea, and the stridulous respiration, are sufficiently indicative of the character of the lesion. Marked vertical movement of the larynx in respiration has been thought to indicate obstruction in that organ; and slight movement, or want of it, to indicate obstruction in the trachea;⁸ but this sign is by no means thoroughly reliable for such discriminative diagnosis. Auscultation of the larynx and trachea furnishes little information as to the seat of the lesion, the sounds being too confused for due interpretation.

¹ Lüning, Die Laryngo- und Tracheo-stenosen im Verlaufe des Abdominaltyphus, und ihre chirurgische Behandlung. Arch. f. klin. Chir., Bd. xxx. H. 2, S. 225–340, und H. 3, S. 523–619; abstract in Internationales Centralblatt für Laryngologie, u. s. w. Aug. 1884, S. 72.

² Küchler, Deutsche Klinik, 1 Mai, 1869, S. 169. (The patient in this case died five years after the wound, from typhoid fever.)

³ Med.-Chir. Trans., vol. xxv. p. 230. London, 1842.

⁴ Thornton, Med. Times and Gazette, June 27, 1874, p. 704.

⁵ Worthington, loc. cit.; Hall, Brit. Med. Jour., April 26, 1884, p. 814; Bayer, Rev. Mens. de Laryngologie, etc., Juin, 1884, p. 95; Ashhurst, Med. and Surg. Reporter, 1880.

⁶ Stoerk, Klinik der Krankheiten des Kehlkopfes, des Nase, und des Rachens, S. 436. Stuttgart, 1880. (In this case a conical canula reached clear into the right bronchus); Mackenzie, op cit., p. 537.

⁷ Cited by Riegel, loc. cit., p. 483.

⁸ Gerhardt, Lehrbuch der Auscultation und Percussion, S. 219. Tübingen, 1871.

Impairment of the vesicular respiratory murmur is perhaps a constant phenomenon; its extinction is indicative of great occlusion of the canal. According to Gerhardt, the head is apt to be held backward in laryngeal constriction, and slightly depressed, with extended neck, in tracheal constriction.

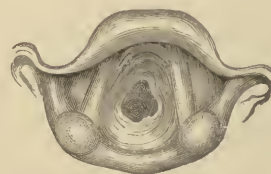
Rapidly progressing symptoms, developing within a few days or a few hours, are indicative of intrinsic stenosis of a temporary character. Slowly progressive symptoms, occupying weeks, months, or years, are indicative of permanent constriction, whether by compression or by occlusion. Symptoms developing during croup, diphtheria, measles, and scarlatina, are usually indicative of obstruction by pseudo-membrane, but may be due to paralysis of the dilating muscles of the glottis, or to spasm. Symptoms developing during enteric fever are indicative of laryngeal perichondritis. Evidence of syphilis indicates gumma, or cicatricial constriction.

Laryngoscopy or laryngo-tracheoscopic inspection is necessary to determine the seat and character of the lesion. The picture of stricture of the glottis caused by adhesion of the two arytenoid cartilages, is so much like that of paralysis of the posterior crico-arytenoid muscles, that the two conditions are liable to be confounded. Tuerck¹ has described and illustrated the laryngoscopic image in several cases of compression-stenosis of the trachea, by tumors external to the tube. Compression-stenosis from involution of the trachea by aneurism of the arch of the aorta (Fig. 1134) and from acute bronchocele, has been recognized laryngoscopically by myself,² and similar stenosis due to mediastinal tumor has been recognized in the same manner by Pastau³ and by Riegel.⁴ An admirable illustration of concentric stricture of the trachea (Fig. 1135) has been given by Mackenzie.⁵ Tracheal stricture, however, can by no means be always thus detected; but the positive absence of laryngeal

Fig. 1134.



Fig. 1135.



Involution of trachea by aneurism of the arch of the aorta. Extreme inspiratory dyspnea.

Concentric constriction of the trachea. (Mackenzie.)

obstruction, and lack of sufficient evidence of sources of compression externally, strongly support the inference of intrinsic tracheal stricture. Instrumental exploration is sometimes the sole means of determining the presence of intra-tracheal stricture; but the manipulation is not always feasible.

Laryngoscopically, carcinoma of the larynx in its early stages cannot be discriminated from chronic inflammatory tumefaction of the mucous membrane, or of the perichondrium. Any swelling existing externally, however, would be likely to be diffuse and painful if due to carcinoma, and circumscribed and painful if due to perichondritis.

¹ Op. cit., S. 507 u. folg.

³ Virchow's Archiv, Bd. xxxiv. S. 236.

⁵ Op. cit., p. 536.

² Op. cit., p. 595.

⁴ Ibid., Bd. xlix. H. 2, S. 193.

The importance of laryngoscopic inspection is not to be underrated; without it, the risk is run of making a useless incision above the point of constriction, as has been done more than once.¹ Even when the larynx is seen to be the seat of constriction, extensive stricture of the trachea may remain unrevealed, as in a case of unavailing tracheotomy graphically described by Mr. Thornton.² (Fig. 1136.) When the air-tube has become perforated externally from destruction of cartilage, or from any other cause, digital or instrumental palpation can be employed to detect the seat and character of the stenosis. The same manipulation is applicable after surgical incisions into the passage. Compression-stenosis from intra-thoracic tumor is diagnosed chiefly by auscultation and percussion of the thorax. Cough, dyspnoea, and aphonia, are additional symptoms, observed usually as the result of pressure upon the inferior laryngeal nerve. In some instances the dyspnoea is manifested wholly, or in greater measure, in the expiratory phase of respiration, under which circumstance the phenomena may be incorrectly regarded as entirely asthmatic.

Prognosis.—In extrinsic stricture, the prognosis depends entirely upon the prospect of relieving or curing the condition which causes the involution of the wall of the air-tube. It is unfavorable, therefore, in cases of aneurism of the aorta, tumors of the mediastinum, irremediable hypertrophic disease of the thyroid gland, and cervical tumors insusceptible of extirpation. Long-continued compression may produce anæmia, and collapse of the lung with hydrothorax.³

Even though the stricture be beyond relief, the higher up the point of compression, the better is the prognosis as to life whenever tracheotomy is practicable below the obstruction.

Intrinsic stricture due to benign neoplasm is remediable by extirpation of the growth; and the higher up it is located, the greater the opportunity for removal under laryngoscopy, and the better, therefore, the prognosis. The same remark is applicable to stenosis from a foreign body. When beyond the reach of manipulation through the mouth, the question of a necessary laryn-

Fig. 1136.



Syphilitic cicatricial narrowing of trachea. Ulceration extended from vocal cords to lower end of stricture. (After Thornton.)

¹ Dict. de Méd. et de Chir. Prat., t. xx. p. 293. Art. Larynx. Paris, 1875.

² Op. cit., p. 34.

³ Moore, Dub. Jour. Med. Sci., November, 1876, p. 433.

gotomy or tracheotomy adds a proportionate gravity to the prognosis, which, however, remains good if the operation be not delayed. In very favorable cases, laryngeal stricture may be overcome by systematic dilatation, so that the canula can be permanently withdrawn from the artificial opening. Its continuous retention is requisite, however, in most cases—in America at least—the tendency to reproduction of the stricture being usually insurmountable. Tracheal stricture presents an unfavorable prognosis in all instances in which the obstruction is beyond the point at which tracheotomy can be made available, tracheal stricture being hardly ever susceptible of dilatation. When sufficiently high up to permit a tracheotomy, the prognosis as to life is favorable should the operation be successful. When irremediable by operation, death usually occurs gradually by coma. Sometimes it is sudden, by occlusion of the constricted passage with blood, pus, or mucus.

Treatment.—In compression-stenosis, the treatment is necessarily purely symptomatic in many instances, the cure of the stenosis being entirely dependent upon cure of the disease by which it has been caused. Thus a foreign body is to be withdrawn from the œsophagus, an enlarged thyroid gland to be reduced in volume, released from tension, or extirpated, as may be indicated, and so on through the group of lesions which may produce the compression. Relief to the dyspnœa can be afforded by tracheotomy, provided that the opening can be made below the point of compression.

Occlusion-stenosis from causes of temporary character, such as spasm, inflammatory tumefaction, œdema, hemorrhagic effusion, pseudo-membrane, foreign body, and neoplasm, requires the treatment proper to those conditions.

Should suffocative apnœa be threatened, prophylactic tracheotomy becomes indicated, whether the stenosis be temporary or permanent in character; but the operation may fail to afford relief, should the strictured portion of the canal be so far below the artificial opening as to be beyond the reach of a tube.

Stricture of permanent character requires an artificial opening into the passage below the seat of stricture, as an initial procedure. In the majority of instances, a canula has to be worn during the remainder of the patient's life; but much can be done in some cases, especially those of laryngeal stricture, towards restoring the normal calibre of the passage, so that the canula may be definitively removed. In exceptional instances, dilatation can be effected without previous tracheotomy; but there is considerable doubt whether the necessary manipulations are justifiable except in cases of very moderate occlusion of the canal.

Laryngoscopy has given great impetus to treatment by dilatation. Desault, as far back as 1793, while favoring catheterization of the air-passage in tracheal stenosis, if due to compression by tumor or by foreign body in the œsophagus, as well as in stricture due to wound, on the whole preferred tracheotomy. More than half a century later, and just about the time that laryngoscopy was attracting professional attention, this plan was revived by Bouchut, under the term "tubage" of the glottis,¹ chiefly in connection with occlusion from acute inflammatory processes; but the manipulation was not well borne by the parts, and tracheotomy had to be performed in every instance.

When adhesions exist between vocal bands, ventricular bands, or arytenoid cartilages, they should be divided with the knife or the galvano-cautery, before dilatation is attempted. Re-adhesions are frequent after both procedures. These operations are usually performed through the mouth. In a case of extensive adhesions between the vocal bands, Dr. Eysell,² of Halle,

¹ Bulletin de l'Académie de Médecine, t. xxiii. 1858.

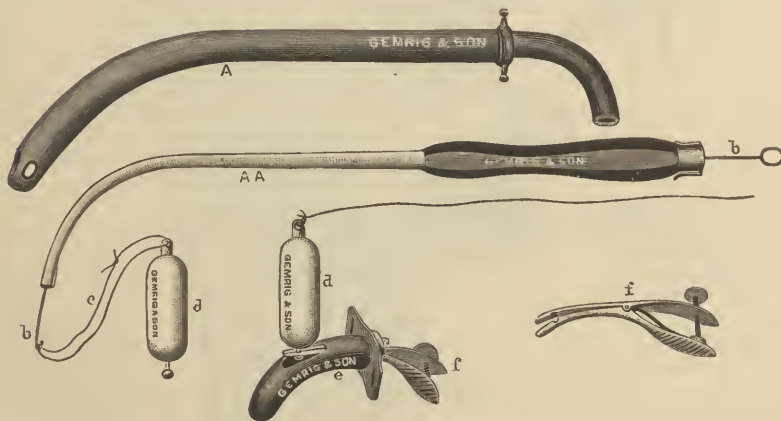
² Med. Times and Gaz., Oct. 17, 1874; Am. Jour. Med. Sci., June, 1875, p. 275.

passed a tenotome through the cicatrix, and guided its subsequent movements by laryngoscopic reflection. The galvano-cautery, usually considered a safe instrument, is not invariably safe. In one case in which it was employed to divide an adhesion between the epiglottis and the pharynx, hemorrhage ensued to such an extent as to require ligation of the external carotid artery.¹

In occasional instances, the stenosis seems amenable to dilatation of the simplest character. Thus Asch² cured a case by dilatation with sounds of flexible metal. In some cases, indeed, mere utilization of the dilating power of a stream of air through a fenestrated canula has been found sufficient for the purpose.³

Methodized dilatation, persistently practised, has produced remarkable results in the hands of Schroetter, of Vienna;⁴ and the plan pursued by him is universally acknowledged to be the most effective. Before describing this method, allusion must be made to a successful result by Liston,⁵ in a case after suicidal wound of the crico-thyroid membrane, in which he began with bougies no larger than a darning needle, and finished by inserting a canula equal in diameter to the largest œsophageal tube, which was retained in position for fifteen days. To lessen the salivation excited by dilating tubes, retained in position for hours or days, Trendelenburg⁶ employs small segments of dilators intended to occupy the larynx only, a strong and firmly attached thread alone protruding from the mouth. The thread excites

Fig. 1137.



Appliances used by Schroetter in dilating stenosis of the larynx.

less salivation, and conducts much less saliva into the larynx. It is on this principle that Schroetter has based his method. He accustoms the parts to the presence of a catheter or bougie for the first few days—a precautionary manipulation which should not be neglected. He then removes the canula daily, and inserts a catheter through the constriction, allowing it to remain

¹ Heinze, Archives of Laryngology, p. 379. 1880.

² Archives of Laryngology, p. 62. 1880.

³ Gerhardt, Arch. f. klin. Med., Bd. xli. 1873.

⁴ Laryngologische Mittheilungen, S. 32. Wien, 1875; Beitrag zur Behandlung der Larynx-stenosen. Wien, 1876.

⁵ Edinburgh Med. and Surg. Jour., vol. xxix. p. 118. 1828.

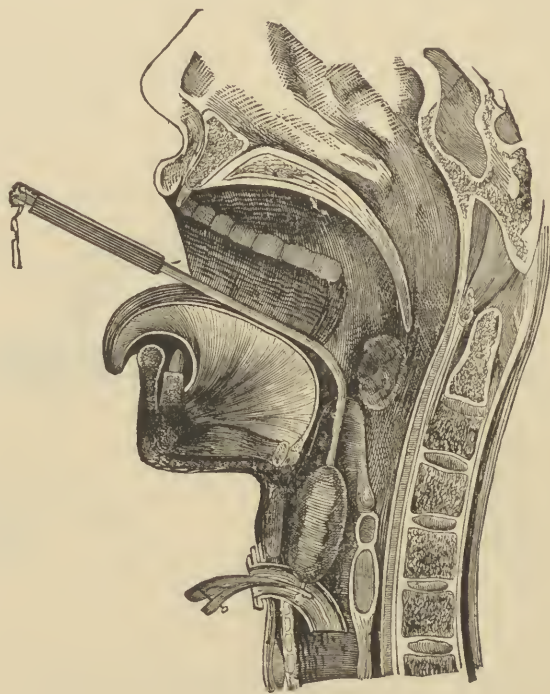
⁶ Arch. f. klin. Chir., Bd. xiii. S. 334.

from five minutes to half an hour, as may be. As soon as a No. 15 catheter can be tolerated, he begins with a series of twenty-four special, graduated dilators of smooth, pure tin, shaped to the normal glottis (Fig. 1137 *d*).

These dilators are each four centimetres long, and are graduated in bulk from six to sixteen millimetres. Through each passes a rod, having an eye at the top for affixing a thread, and a knob below, or a perforation by which the bougie can be secured by a pincette (*f*) or by a bolt, passed through the fenestrated canula (*e*) in the artificial opening. The bougie is inserted by means of a canulated director (*AA*), fitted to a perforation surrounding the eyed rod at top, the thread (*c*) attached to which has previously been drawn through the director by a special wire-hook (*b*), and is then secured at the distal end.

As soon as the bougie has been secured at the lower end, as shown in the diagram (Fig. 1138), the thread is loosened from the director, and that instru-

Fig. 1138.



Schroetter's method of dilating stenosis of the larynx. (Labus.)¹

ment is withdrawn, leaving the bougie in position and the thread hanging from the mouth. The thread being secured, the bougie remains in position day and night, until it becomes necessary to cleanse it, or desirable to replace it with a larger one, when it is released below, and withdrawn by traction on the thread. When the dilatation has been completed, the external wound is closed. Reconstriction is prevented by the daily use of curved, hard-rub-

¹ Il caterismo e la dilatazione mecanica nelle stenosi della larynge. Milano, 1876.

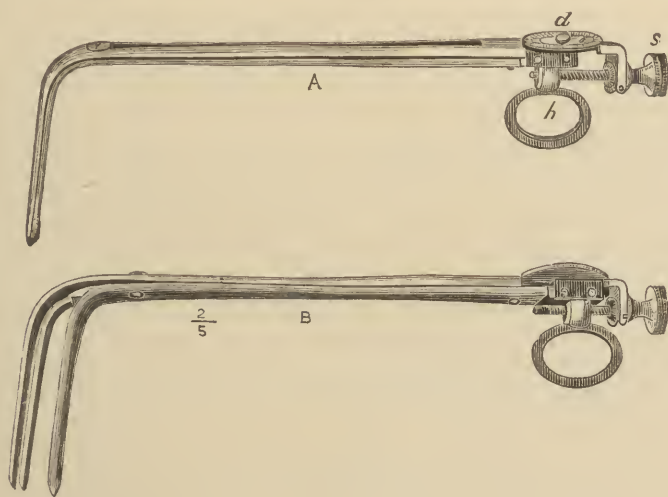
ber tubes, shaped like the bougies at the laryngeal end (Fig. 1137 A), and introduced through the mouth—a curved offset being inserted in the protruding portion, to carry downward the mucus which is coughed out. These tubes are retained in position for from fifteen to thirty minutes. Patients are taught to use them for themselves. The treatment consumes from six to eighteen months in most cases, but occasionally it is much more rapid.

McSherry, of Baltimore, has reported good results in his own hands by Schroetter's method of dilatation,¹ in a case in which the lumen of the larynx had been reduced in size to that of a goose-quill. Weinlechner² recommends passing a silk thread from the mouth through the tracheal tube, and knotting it in front, so as to retain it as a permanent guide in placing the sounds or bougies in position. It is said not to interfere with speech or with deglutition, and to need removal only when it becomes soiled. The sound can be borne for from half an hour to three or five hours. A patient upon whom laryngotomy had been performed after typhoid fever, in 1871, was cured of stenosis in this way, and died in 1877, of pulmonary phthisis.

Artificial vocal apparatus has been successfully introduced after dilatation of laryngeal stenosis.³

Mechanical dilators, for more rapid work, have been employed by Schroetter, Mackenzie (Fig. 1139), Navratil, and others. These are introduced by the

Fig. 1139.



Mackenzie's laryngeal dilator.—*a*, the instrument closed; *b*, the instrument opened; *s*, screw, by which to separate the blades; *d*, dial-plate, indicating the amount of separation; *h*, ring for finger.

mouth. Stoerk⁴ dilates from below with a two-bladed dilator, and McSherry, of Baltimore, with a three-bladed one (Fig. 1140). Rapid dilatation, however, has rarely been successful, and has been found liable to excite inflammation and œdema.

¹ Medical News, May 5, 1883, p. 506; Trans. Med. and Chir. Faculty of Maryland, 1883.

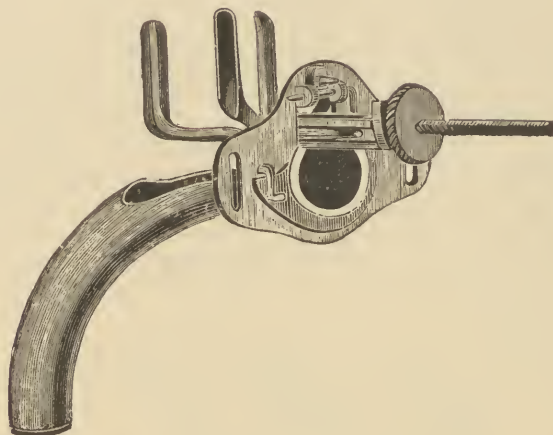
² London Medical Record, April 15, 1878, p. 180.

³ Wegner, Verhandlungen der Deutschen Gesellschaft für Chirurgie, S. 101. 1878; London Med. Record, June 15, 1878, p. 269.

⁴ Wien. med. Woch., No. 46, 1879.

Strictures sometimes require external operations to restore the calibre of the canal. Thus in a case of traumatic stricture, after suicidal wound, in

Fig. 1140



McSherry's modification of Stoerk's dilator for laryngeal stenosis.

which the cricoid cartilage and part of the thyroid were divided to ascertain the cause of the constriction, Mr. Henry Lee¹ found the posterior part of the upper tracheal ring approximated to within a quarter of an inch of the cricoid cartilage. He removed the ring in great part with scissors, and introduced a canula with the inner opening upward, to prevent recontraction. In a somewhat similar case, Prof. Ashhurst, of Philadelphia, dissected off some dense cicatricial tissue, and then removed a portion of the displaced cricoid cartilage with scissors, to overcome a stenosis at the junction of the thyroid and cricoid.² Resection of the larynx is sometimes performed,³ a portion of the anterior cartilaginous wall being removed to afford room for a T-shaped canula, which is retained in position until cicatrization has taken place. Some surgeons deem this procedure preferable to attempts at dilatation.

LARYNGITIS.

Laryngitis, inflammation of the larynx, is the term in general use to designate superficial inflammation of the mucous membrane of the interior of the larynx—*simple or catarrhal laryngitis*. When loss of tissue takes place, as occurs under certain systemic conditions, notably tuberculosis and syphilis, the affection is termed *ulcerative laryngitis*. *Submucous laryngitis*, *parenchymatous laryngitis* (Mandl), is a deeper-seated inflammation, involving the submucous connective tissue in addition, and sometimes other tissues also, such as the glands, muscles, and cartilages. Suppurative inflammation of the sub-

¹ Med. Times and Gaz., May 16, 1874, p. 548; Trans. Clin. Society, vol. vii., London, 1874; Am. Jour. Med. Sci., July, 1875, p. 175.

² Med. and Surg. Rep., Aug. 14, 1880, p. 142.

³ Reyher, Arch. f. klin. Chir., Bd. xix. S. 334; Heine, *ibid.*, S. 514; Bruns, Berlin. med. Woch., Nos. 38, 39. 1880; Archives of Laryngology, p. 393. 1880.

mucous connective tissue, when diffuse, is described as *phlegmonous laryngitis*; when circumscribed, as *abscess of the larynx*. Inflammation of the perichondrium is termed *laryngeal perichondritis*, and inflammation of the cartilages *laryngeal chondritis*.

ACUTE LARYNGITIS.

SIMPLE OR CATARRHAL LARYNGITIS.—This occurs idiopathically, deuteropathically, and traumatically. All these varieties may be associated with tracheitis or bronchitis on the one hand, or with pharyngitis or rhino-pharyngitis on the other. In the former case, the process is usually confined to the interior of the larynx; in the latter, both surfaces are commonly involved. *Acute idiopathic laryngitis* is usually the result of undue exposure to cold or moisture. Among other causes may be cited direct local irritation by mechanical and chemical products, or by over use of the voice; transmitted local irritation in dentition, in stomatitis, and in glossitis; constitutional poisoning, sometimes idiosyncratic, by iodine, antimony, mercury, and other drugs. Occasionally it is rheumatic in origin, and at times associated with synovitis. *Acute deuteropathic laryngitis* occurs in many cases of arthritis, thrush, diphtheria, pneumonia, acute tuberculosis, syphilis, typhus and enteric fever, smallpox, measles, scarlet fever, erysipelas, and pyæmia. *Acute traumatic laryngitis* is the result of local injury, whether through accident, carelessness, or design.¹

Acute catarrhal laryngitis is usually diffuse. Sometimes it is circumscribed to one or more special structures, such as the epiglottis, a vocal band, or the like, and—when not traumatic—chiefly so in cases of syphilis, carcinoma, tuberculosis, and lupus. The diffuse form may run its entire course to recovery in from twenty-four hours to ten days. The circumscribed variety, when dyscrasic, usually subsides into chronic inflammation of indefinite duration. When traumatic, its duration varies with the character of the injury which has excited the lesion.

The special surgical interest in laryngitis resides in the location of the inflammatory process, rather than in its intensity. The pathological phenomena of congestion, tumefaction, and infiltration, with their sequelæ, are similar to those occurring in inflammation of mucous membranes generally; but the fact that any considerable swelling in the interior of the larynx, or at its superior outlet, embarrasses respiration by opposing a mechanical barrier to access of air to the lungs in sufficient quantity, renders laryngitis peculiarly menacing to life. Hence every case should be carefully scrutinized from time to time by laryngoscopic inspection, not only to discern the progress of the inflammatory process, but to learn the effect of remedial measures. It will be observed in most instances that the entire laryngeal mucous membrane is congested and swollen. The features of the larynx are much thickened, the tumefaction being symmetrically bilateral as the rule. Movements of the epiglottis may be impeded by the tumefaction of its mucous membrane, so that it is depressed with evident muscular effort, or remains erect. Circumscribed inflammations are recognized by linear, mottled, or diffuse congestions, as may be, and by local tumefactions. Both circumscribed and diffuse congestions and tumefactions vary within extreme limits. Accumulations of mucus, here and there, simulate points of ulceration; for it is sometimes extremely difficult to determine, in the reflected image, whether a given abnormal appearance be sunken or in relief. Mucus,

¹ See under Wounds and Scalds (page 224), Fractures (page 251), and Foreign Bodies (page 260).

unless very adherent, can usually be detached by cough, and when cough fails, by douching. But ulceration does not occur in simple catarrhal laryngitis, and even erosions are unusual. Paresis of some of the muscles which close the glottis will often be recognized, either by gaping of the entire chink, or by gaping of its inter-arytenoidal extremity. The paresis is due to intermuscular infiltration and not to disease of the nerve tracts. Should the laryngitis be severe, œdema of the larynx (discussed at page 243) may ensue.

The *symptoms* are, in mild cases, pain, cough, and impairment of voice, without special pyrexia. In severe cases phenomena of fever are present, and difficulty in deglutition and in respiration may be added to the symptoms mentioned, themselves much more aggravated.

The *diagnosis* rests upon the subjective group of symptoms enumerated above, and the objective manifestations noted in the laryngoscopic image.

The *prognosis* is favorable in mild idiopathic cases of diffuse laryngitis. It is favorable even in severe cases, if subjected to systematic laryngoscopic supervision. Neglected, such cases sometimes terminate fatally by suffocation for want of proper surgical interference. In deuteropathic cases, the prognosis depends largely on the disease of which the laryngitis is an epiphenomenon, but is rarely as favorable as in the idiopathic affection, erysipelatous laryngitis being of especially grave augury. In traumatic cases, the prognosis is favorable only when the injury has been unimportant. In all instances, acute laryngitis, unless skilfully handled, is liable to be followed by permanent malnutrition of the mucous membrane, rendering it liable to recurrence of subacute if not of acute inflammation, repetitions of which often merge gradually into chronic laryngitis. Chronic laryngitis thus induced, especially in persons with constitutions otherwise impaired, may, if neglected, terminate in ulceration. This opinion, however, is not shared by the profession generally; yet even chondritis and necrosis may follow acute idiopathic laryngitis. Sometimes, too, morbid growths become developed in immediate sequence to idiopathic laryngitis; while myopathic palsies of the vocal bands are occasional relics of the inflammatory processes.

In the already unhealthy subject, acute superficial laryngitis may be succeeded by abscesses, intra-laryngeal or peri-laryngeal.

Circumscribed laryngitis, being usually indicative of inherent or acquired cachexia, requires a much more guarded prognosis than the diffuse variety.

Treatment.—Whether mild or severe, small doses of mercuric chloride, in frequent repetition, seem to produce a decidedly beneficial effect on inflammations of the laryngeal mucous membrane, as upon the mucous membranes everywhere. Mild cases may be judiciously treated by the administration of an effective aperient, by restriction from butcher's meat, and by the continuous application of cold to the neck, whether by wet compresses, by bags of ice or of iced water, or by coils of rubber or of metallic tubing. Severe cases may require, in addition, leeching at the supra-sternal notch, and the systematic administration of salines, or even of antimonials, with still greater restriction in variety of diet. The food should be semi-solid, so as to guard the larynx from local irritation in swallowing. Inhalations of the vapor from steaming water impregnated with benzoin, creasote, or oil of pine, or with chamomile, sage, or the like, often afford great relief. Astringent sprays, unless quite weak, are not likely to be useful, and direct intra-laryngeal mopping is apt to be actually injurious. The accompanying pyrexia is perhaps best treated by minute doses of aconite at short intervals, until the pulse has become sensibly affected, and then at intervals sufficient to maintain the effect. Rest of the part and of the entire body, is indicated in all instances. Cases dependent upon dyscrasie require appropriate constitutional medication. Cases attended

with great tumefaction require the surgical treatment detailed under œdema of the larynx (page 249).

OTHER FORMS OF LARYNGITIS.—*Submucous laryngitis*, more frequently regional than diffuse, is recognized by its greater tumefaction and by the proportional severity of its local and constitutional symptoms. It requires active antiphlogistic treatment and regimen. *Hypoglottic submucous laryngitis* is not clearly differentiable, clinically, from what has been described as sub-glottic œdema of the larynx (p. 244). Continuance of the tumefaction long after tracheotomy, is presumptive evidence of cell-infiltration rather than of effusion of serum.

Phlegmonous laryngitis exhibits still more urgent symptoms, and demands careful surgical supervision. *Ulcerative laryngitis*, and inflammation of the cartilages and of their investment, are mentioned in connection with the affections in which they are encountered.

ACUTE INFANTILE LARYNGITIS.—In children, acute laryngitis is much more severe than in adults. Not only is the inflammatory process more active, but the tissues possess a special sensitiveness, direct and reflex, which induces spasm of the glottis even on what appears the slightest provocation. These peculiarities add to the danger of the disease dependent upon the smaller proportionate calibre of the larynx. In children, too, slight initiatory distress often escapes detection, or may be purposely concealed by an imprudent nurse who has carelessly exposed the child to draft or dampness. Thus the severer symptoms are apt to occur with a suddenness which has been described as peculiar to the affection. In the majority of instances, however, strict inquiry will reveal the immediate precedence of a stomatitis, a coryza, a pharyngitis, or a bronchitis.

Symptoms.—It is usually at night that the severer symptoms alluded to are first manifested. These are paroxysmal cough and stridulous inspiration, with flushed face, accelerated pulse, difficult breathing, restless demeanor, and manifestations of pain in the throat, sometimes causing the infant to cry while grasping the neck after each paroxysm. The initial paroxysm usually subsides in a few seconds, and sleep is immediately resumed. Similar paroxysms recur at varying intervals, often with increasing frequency, and continue to recur for a day or two, or for several days, as may be. In some cases they are very slight and unimportant. In others they are severe and threatening. Suffocation occasionally results.

Diagnosis.—It is rare that laryngoscopy is available in children. The appearances noted in such an examination are mainly those mentioned in speaking of the laryngitis of adults. Paralysis of the posterior crico-arytenoid muscles has been detected occasionally, accounting for the stridor otherwise attributed to spasm of the glottis. The apparent suddenness of the attack, the character of the subjective symptoms, and the elicitation of tenderness or pain on pressing the larynx externally, suffice for the diagnosis.

Prognosis.—This is favorable in otherwise apparently healthy children. Recurrence and subsidence into chronic laryngitis are even more frequent than in adults.

Treatment.—Restriction in diet, moderately antiphlogistic measures, and the internal administration of antispasmodics, constitute the most effective means of treatment. Mercuric chloride is indicated, as in the adult. If the tendency to spasm be absent, cold may be applied externally, but if spasm be present, warm turpentine stupes are preferable. Sprays and intra-laryngeal applications are improper. Inhalations of vapor of warm water, simple or impregnated with soothing and balsamic drugs, are often useful. The

warm bath is an excellent relaxant, and may be used systematically at intervals of four hours or longer. Relaxing inhalations of chloroform or of amyl nitrite may be necessary in the presence of threatening spasm of the glottis. Should the disposition to spasm be at all pronounced, precautionary tracheotomy will be indicated.

CHRONIC LARYNGITIS.

Chronic laryngitis may be idiopathic, deuteropathic, or traumatic. *Idiopathic chronic laryngitis* may affect the superficial layers of the mucous membrane only (*chronic catarrhal laryngitis*), or the glands likewise (*chronic glandular laryngitis*). The former variety may be a sequel of repeated attacks of acute laryngitis, or may occur in extension of a similar affection of the pharynx. Sometimes it appears due to the inordinate use of tobacco, or of alcohol, or of condiments. The latter variety is almost always an extension of a similar affection of the pharynx, and is most frequent in individuals who are compelled to make excessive use of the voice. Both varieties sometimes occur in association with chronic hyperæmia or inflammation of the gastro-intestinal mucous membrane. Males are affected more frequently than females, and adults more than children. *Deuteropathic chronic laryngitis* occurs in arthritis, tuberculosis, syphilis, lupus, sarcoma, and carcinoma, as part of their pathological history, and is sometimes a permanent sequel of the laryngitis of measles, scarlet fever, smallpox, croup, or diphtheria. It may be catarrhal, glandular, or suppurative. *Traumatic chronic laryngitis* occurs as a result of wounds and injuries sustained by the mucous membrane. It may be catarrhal and suppurative. All the varieties may be associated with tracheitis.

CHRONIC CATARRHAL LARYNGITIS.—This is a chronic inflammation of the mucous membrane, sometimes attended with hypersecretion. Some capillaries and veins upon the surface are usually dilated, and in some cases even those in the submucous tissue. Erosions are infrequent. Infiltrations into the submucous connective tissue, and proliferations of the connective-tissue elements, are not uncommon; and permanent thickenings, circumscribed or diffused, regular or irregular in conformation, are occasional results. Permanent thickenings are more frequent in the deuteropathic varieties.

CHRONIC GLANDULAR LARYNGITIS.—There is inflammation of the mucous glands, as well as of the superficial layers of the mucous membrane, and hyperplasia of their histological elements. Desquamation and degeneration of immature epithelium replace, in greater or less degree, normal secretion.

A peculiar variety of chronic glandular laryngitis—desiccative laryngitis, *laryngitis sicca*—occurs chiefly in females. The viscid products of secretion and desquamation adhere to the surface of the mucous membrane, and undergo desiccation there into annular and fragmentary fetid crusts, yellowish, greenish, or brownish in color, according to their admixture with mucus, pus, or blood. At intervals of a day, or of several days, these crusts are detached by violent efforts of cough, having sometimes become partially detached by superficial suppurative inflammation beneath them. Excoriations, in part hemorrhagic, are sometimes to be noticed at the points from which the crusts have been detached. The crusts themselves are composed of pus and mucus, and much more largely of desquamated epithelium, deformed, degenerated, and fatty. In most of the instances seen by myself, the crusts have occupied the mucous membrane in the domain of the cricoid cartilage and the upper rings of the trachea. In some they have occupied a ventricle; in others they have bridged

the commissure between the vocal bands anteriorly. In a single instance—submitted for consultation by Dr. Smith, of Frederick, Maryland—the fetid laryngo-tracheal disease was associated with fetid rhino-pharyngitis. Similar instances have been cited by Fraenkel,¹ Moure,² and others.

CHORDITIS TUBEROSA is the term applied by Tuerck³ to designate a chronic inflammation of the vocal bands, characterized by minute whitish tumors or nodules on their upper surface. It seems to be peculiar to singers. In many instances the lesion is unilateral, the left band being affected most frequently. Its pathology is as yet conjectural. Local congestions, resulting from special vocal efforts during mild attacks of catarrhal laryngitis, may start local hyperplasias, terminating in permanent nodulations.

CHRONIC HYPERTROPHIC LARYNGITIS.—Occasionally in cases of non-constitutional origin, but more frequently in those dependent on tuberculosis and on syphilis, the tissues undergo hypertrophy. The lower or muscular structure of the vocal bands is the most frequent seat of this process, which sometimes induces sufficient constriction to demand tracheotomy.

CHRONIC TUBERCULOUS LARYNGITIS, in most instances eventually an ulcerative lesion, and frequently productive of perichondritis and necrosis, especially of the arytenoid cartilages, is usually due to secondary tuberculous infiltration. As inspected laryngoscopically, the pathologic process in individuals with rapidly caseating pulmonary lesions, begins in a congestive catarrhal laryngitis, leading within a few weeks to the development of minute, non-suppurative ulcerations, upon the posterior surface of the epiglottis and elsewhere. These multiple ulcerations extend both in depth and in periphery, two or more coalescing when sufficiently close together, and then exciting contiguous suppurative ulceration in the adjoining tissues. Great swelling of the epiglottis gradually supervenes in many instances, and is in its turn sometimes followed by intumescence in the ventricular and vocal bands, and in the inter-arytenoid and aryteno-epiglottic folds. Ulceration, tuberculous and suppurative, takes place in some of these swollen tissues, particularly in the epiglottis, the arytenoidal extremities of the vocal bands, the internal face of the arytenoid cartilage, and the inter-arytenoid fold; but it may take place anywhere.

In the more sluggish cases of pulmonary tuberculosis, beginning in localized pneumonitis, the earliest pathological manifestation in the larynx is pallor of the mucous membrane. Following this, the sharp outlines of the individual features of the larynx gradually undergo characteristic thickening, especially at points where lymphoid tissues predominate. The most marked manifestation is over the supra-arytenoid cartilages, whose sharply-defined, prismoidal

outlines undergo transformation into pyriform swellings (Fig. 1141); the base of the morbid tumefaction occupying the apex of the normal structure, and tapering forwards along the fold stretching from the arytenoid cartilage to the epiglottis. The epiglottis sometimes becomes several times as thick as when normal. In the inter-arytenoid fold the tumefaction is sometimes diffuse, sometimes circumscribed. When circumscribed, it may be in an unbroken, spheroidally curved mass, or in a mass with

Fig. 1141.



Pyriform swellings of tuberculous laryngitis.

¹ Ziemssen's Cyclopaedia, vol. iv. p. 140.

² Revue Mensuelle de Laryngologie, etc., Juin, 1883, p. 162.

³ Op. cit., S. 164.

two or more acuminations. These tumefactions may continue the sole local manifestations of laryngeal tuberculosis; or extensive suppurative inflammations may take place upon their surface and in their substance. Perichondritis and necrosis are not uncommon, the posterior vocal process being attacked most frequently. Thence the disease is often propagated to the bodies of the arytenoid cartilages, which, undergoing necrotic destruction, may be expectorated in minute fragments, or in bulk. Necrosis of the cricoid cartilage is infrequent, and necrosis of the thyroid quite rare.

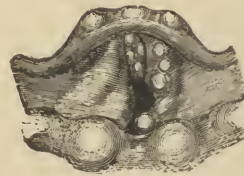
SYPHILITIC CHRONIC LARYNGITIS, often subacute rather than chronic, occurs both in the secondary and tertiary stages of syphilis. When occurring within a few months after the primary affection, it is presumptively secondary; when not occurring until after the lapse of a year or more, it is presumptively tertiary. The lesions of the one form sometimes run insensibly into those of the other, so that discrimination becomes quite impracticable. Mucous patches or papules have been detected laryngoscopically in many instances; and from their recognition an unjustifiable inference has been drawn that they are precursors of all laryngeal ulcerations in the secondary period. Very frequently, the history of exposure is the sole guide to early diagnosis, the local lesions being indistinguishable from those of non-syphilitic laryngitis until after ulceration has taken place. Symmetric, bilateral distribution of the ulceration, and symmetry in the patches of ulceration, may usually be regarded as factors in the differentiation of syphilitic from tuberculous laryngitis. Ulceration, of the epiglottis especially, is one of the earliest phenomena in the tertiary stage. Gummata are later manifestations as a rule. Deep and destructive ulceration is the ultimate outcome in the unarrested disease, and this leads to cicatricial stenosis in many cases of recovery.

Fig. 1142.



Gumma in inter-arytenoid fold.

Fig. 1143.



Multiple gummata. (Mandl.)

Gummata occur singly (Fig. 1142), or in groups, (Fig. 1143), some as small as millet-seed, some as large as hazel-nuts. The gummata are likely to undergo ulceration, and the process thus set up often extends to the cartilages, entailing great destruction of tissue.

Symptoms of Chronic Laryngitis.—The subjective symptoms of ordinary chronic, catarrhal and glandular laryngitis, comprise cough, hoarseness, and annoying sensations referred to the part, sometimes of dryness, sometimes as of the presence of a foreign body. In some instances they are slight; in some they are severe. There is no dyspnoea, little actual pain, and little expectoration. Secretion becomes more abundant under temporary conditions

of exacerbation, after unaccustomed exposure, or during intercurrent attacks of bronchitis and subacute laryngitis.

Similar symptoms attend the denteropathic varieties of chronic laryngitis, until such time as thickenings of tissue on the one hand, or ulcerations on the other, produce their characteristic manifestations of pain, dysphagia, and dyspnoea, with constitutional pyrexia. Swellings at the supra-arytenoid and arytenoid cartilages, and swelling of the epiglottis, produce difficulty in swallowing, while ulceration usually entails great pain in the effort. The dysphagia, first noted with liquids and subsequently with solids also, sometimes becomes extreme—especially in tuberculous laryngitis—aliments of all kinds being painfully regurgitated. Deep ulceration of the epiglottis, especially when lateral and extending along the fold of tissue which binds this part to the pharynx, is apt to induce intense pain running up into the ears, in the direction of the salpingo-pharyngeal fold; pain often more intense than that at the seat of the lesion. This pain is increased on deglutition. It is due, perhaps, to exposure of the auricular branch of the pneumogastric nerve at some portion of its course; for in some instances the pain is but slight, although the superficial ulceration may be extensive. Ulceration in the interior of the larynx produces much pain in some cases, and but little in others, so that this symptom is by no means proportionate to the amount of destruction. Ulceration of the vocal bands produces dysphonia, and sometimes aphonia, but here again the character of the voice is not indicative of the extent of the local lesion. Tumefaction of the ventricular bands, or of the inter-arytenoid fold, produces impairment of voice by interference with the vibration of the vocal bands, or with their due approximation; and tumefactions in both these localities, and in others which encroach upon the glottis, produce dyspnoea and stridor.

Diagnosis.—The subjective symptoms are sufficiently marked to indicate any form of the affection. In chronic catarrhal laryngitis, laryngoscopic inspection reveals diffuse congestion of the mucous membrane, often with dilatation of the capillaries on the epiglottis and on one or both vocal bands, the pearlsh lustre of the vocal bands being often destroyed. The outlines of the laryngeal structures are usually somewhat, and occasionally much thickened. There is often considerable impairment in the movements of the vocal bands on phonation—sometimes due to thickening of their substance, sometimes to thickening of the inter-arytenoid fold, or even of the ventricular bands, and sometimes to infiltration in the muscles. The latter condition cannot be detected, but is inferred from the unequal movements of the two sides, the parietic manifestations being usually more marked on one side than on the other, and sometimes confined to one side exclusively. Erosions are sometimes noticed at the posterior portions of the vocal bands, and erosions or tears in the inter-arytenoid fold. Erosions are occasionally observed elsewhere. Accumulations of mucus are often adherent at projecting parts, and sometimes over a considerable extent of surface. When adherent to the vocal bands, or to the inter-arytenoid fold, they are liable to be mistaken for ulcerations. In chronic glandular laryngitis the enlarged glands can sometimes be detected on the surface of the mucous membrane, and even their orifices, it is said,¹ may sometimes be seen on the epiglottis and on the posterior parts of the vocal bands, appearing as pale specks on the congested mucous membrane, or as small red circles on the pale membrane.

The imperfectly annular crusts of desiccative chronic laryngitis are readily

¹ Mackenzie, op. cit., vol. i. p. 291.

recognized in the laryngoscopic image, in most instances lining the cricoid cartilage, or some of the rings of the trachea, in whole or in part; and the fetid odor emanating therefrom is only too evident. The stenotic condition produced by chronic hypertrophy of the lower surface of the vocal bands—*chorditis vocalis hypertrophica*—is quite apparent, as shown in Figs. 1144 and 1145, taken from Tuerck, which present the laryngoscopic image both before tracheotomy and after it.

Fig. 1144



Laryngoscopic image before tracheotomy.
(Tuerck.)

Fig. 1145.

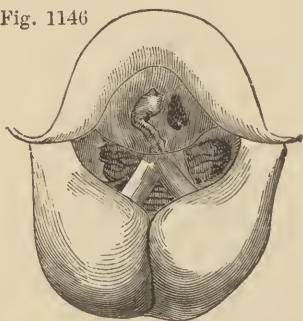


The same after tracheotomy; the cannula
in position. (Tuerck.)

The peculiar turban-like tumefactions of the epiglottis, and the characteristic pyriform swellings of the aryteno-epiglottic folds (Fig. 1146), are alike indicative of tuberculosis, a diagnostic inference usually to be substantiated by the result of a physical examination of the condition of the lungs.

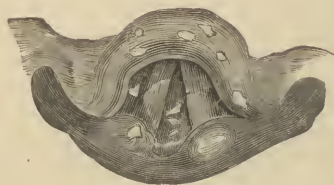
The minute, multiple ulcerations in the early stage of the more rapidly fatal cases, are often sufficiently characteristic (Fig. 1147) to indicate the nature of the lesion.

Fig. 1146



Tuberculous laryngitis, ulcerative stage.

Fig. 1147.



Multiple ulcerations in laryngeal tuberculosis.
(Mackenzic.)

Recognition of the lesions mentioned, and a syphilitic history, or, in its absence, evidence of syphilitic lesions elsewhere, present or past, serve to determine the nature of a chronic laryngitis in syphilitic subjects. In addition to symmetry in ulcerative lesions, the presence of pus upon them may be distinctive. Ulceration of the epiglottis, especially from above downward, is usually indicative of syphilis, particularly when apparently a continuation of a similar lesion in the pharynx. Nevertheless, such lesions occur in tuberculosis likewise. In case of doubt, the detection of a pulmonary lesion at the apex of the lung may usually be regarded as evidence of tuberculosis, the analogous pulmonary lesion of syphilis being much more frequent toward the middle portion of the lung. Furthermore, syphilis and tuberculosis may coexist, and then the characteristic lesions of the two become commingled.

Prognosis.—In simple, uncomplicated cases, the prognosis is favorable, recovery taking place under proper regimen and assiduous topical and constitutional treatment. It is much less favorable in cases which are the direct sequelæ of measles, smallpox, diphtheria, or traumatism, though still susceptible of considerable amelioration. In none of these instances is the laryngitis directly menacing to life. It is liable, however, to excite the development of neoplasms, usually clinically benign, a result which temporarily or permanently increases the gravity of the prognosis.

When the muscular tissue of the vocal bands is involved in the process, as manifested by tumefaction on their inferior surfaces extending beyond their normal borders, the prognosis is unfavorable, this condition rarely subsiding. Indeed, the induced dyspnoea often demands tracheotomy, usually with little prospect of the patient being able to dispense with the canula.

True or false ankylosis of the crico-arytenoid articulation is an occasional result of chronic laryngitis of constitutional origin.

In cases attended by profound dyscrasia of whatever origin, perichondritis, abscess, chondritis, and necrosis, are imminent, and their advent renders the prognosis unfavorable.

The chronic laryngitis of tuberculosis is of very grave augury, as the impression of the diathesis is usually so strong as practically to preclude recovery, even though ulcerative processes may undergo intercurrent repair. Ulceration limited to the epiglottis indicates a much more rapid termination than ulceration in the interior of the larynx. Few cases survive the eighteenth month of marked laryngeal disease. The chronic laryngitis of syphilis is quite prone to cause ulceration, the cicatrization of which may produce stricture. In malignant disease, the prognosis is necessarily unfavorable.

Treatment.—Hygienic measures as to dress, ventilation, and ablutions, and dietetic regulations adapted to the impaired functions of the gastro-intestinal tract, are essential in very many instances. Everything known to induce temporary exacerbation of the malady should be avoided to the utmost limit practicable. Constitutional imperfections should be inquired into, and remedied by appropriate measures, medicinal and otherwise. Systemic measures alone, judiciously as they may be instituted, rarely suffice without topical treatment. The general recognition of this fact has led to the use of a greater variety of local measures than has perhaps been employed in the treatment of any other malady. Much must be done by the medical attendant; much can be left to the patient and the nurse. The condition of excessive or diminished secretion furnishes the chief indication for home-treatment, the object of which should be to keep the parts clean and sweet, and thus give them a chance to get well. Alkalies augment secretion from the mucous membrane, and facilitate its detachment. Hence alkaline sprays, insufflated or inhaled at regular intervals, are indicated in cases of deficient secretion. An aqueous solution of ammonium-chloride, five grains to the ounce, inhaled for three or four minutes four times a day, often answers admirably. Sodium-borate, five grains to the ounce of tar water, with the addition of a drachm of glycerine to facilitate solution, is the remedy most in use by myself. Sodium-bicarbonate, sodium-chloride, sodium-chlorate, sodium-iodide, potassium-iodide, or potassium-chloride, may be substituted in the same doses when either of the other agents fails. In some cases vegetable promoters of secretion, such as pyrethum and jaborandi, may be more serviceable, from one to five minims of the fluid extract to the ounce of water. When indicated, watery extract of opium may be added to relieve pain. A few drops of Cologne water or of some balsamic may render the spray more agreeable. When secretion is excessive, weak mineral astringents are indicated: zinc-sulphate, or zinc-sulphocarbolate, two grains to the

ounce of rose water; alum, five grains to the ounce; ferric chloride, one grain to the ounce; or silver-nitrate, half a grain to the ounce. Inspirations of these sprays should not be sufficiently powerful to draw the medicament into the bronchi. The tube of the instrument should be held several inches from the mouth, so that the misty spray that falls may be deflected into the throat and larynx by the ordinary breath of inspiration. When the tube is placed within the mouth, the greater portion of the spray is condensed upon the pharynx, and does not reach the larynx at all. The face and teeth should be protected from stains of iron and silver by directing the spray through a large glass speculum held between the teeth. Exposure to the outside air should be avoided for half an hour, in case a steam apparatus is used. The ordinary hand-ball instrument is all that is required, for little benefit and some harm may result from the relaxing influence of warm sprays in chronic affections.

In cases of several months' duration, these remedies need to be supplemented by topical astringent and alterant treatment at the hands of the surgeon. The agents most frequently employed by myself are tannin, silver-nitrate, or zinc-sulphate, in uncomplicated cases; iodine, or iodine and carbolic acid, in cases with submucous tumefactions; iodoform in tuberculous cases; and iodoform and acid solution of mercuric nitrate, one part to ten or twelve of water, in syphilitic cases. Syphilitic ulcerations often heal under constitutional treatment without any topical medication whatever. Zinc-chloride and ferric sulphate have not been as useful, in my hands, as tannin, zinc-sulphate, and silver-nitrate. Boric acid has been lauded as a substitute for iodoform in tuberculous cases. Carcinomatous cases are not suitable for active topical treatment. Before making any application, the parts should be thoroughly cleansed with an alkaline spray, such as those already indicated, to which tar water or an emulsion of coal-tar may be added to soothe and disinfect, or with a spray of the solution of hydrogen-peroxide, the best cleanser I have knowledge of, one part of a ten-volume solution to three or four of distilled water. The latter is especially serviceable in cleansing ulcerated surfaces. The entire series of manipulations should be performed with the aid of laryngoscopy. The silver-nitrate, forty grains or more to the ounce, is applied with a brush for a gentle application, or with a firmly secured fragment of the best surgical sponge, used but once, for a thorough one. With a properly curved forceps, toothed to prevent danger of dropping the sponge into the larynx, and firmly locked by a slide-catch, the fragment of sponge may be as small as desired. When a sponge the size of a pea or larger is passed into the larynx, muscular contraction is excited, and a great extent of mucous membrane comes in contact with the remedy. This contraction often amounts to spasm, especially at the initial operation. Hence the solution should be extremely weak at first, say ten grains or less to the ounce, and the strength should be increased only as tolerance is acquired. Sudden death by suffocation has been known to follow the incautious use of this agent.¹ Tannin, best perhaps as a saturated glycerite, may be employed in the same way. Zinc-sulphate, thirty grains to the ounce, propelled on the parts by douche or spray, seems to afford better results than applications by brush or sponge. Silver-nitrate in my own hands is reserved for cases in which the zinc-sulphate has failed. Iodoform or boric acid, in impalpable powder, may be blown upon the parts from a curved tube, as much being used (a grain or more) as is requisite to cover the ulcers. The surgeon's mouth is the most accurate propeller, but his mouth-piece should be provided with a valve to protect him from a return current from the throat of the patient. In many instances several attempts will be neces-

¹ Archiv. f. klin. Chirurgie, Bd. xxxvii. S. 570. 1882.

sary to cover the parts, for cough, often beyond the patient's control, expels the powder. In some cases the powder will not stick to the parts, no matter how passive the patient may be. Great variation in this respect is to be noted in different subjects. A saturated ethereal solution of iodoform, applied with brush or sponge, or even in spray, may be substituted for the powder. When there is great pain due to ulceration, powders containing from one-eighth to one-fourth of a grain of morphia may be propelled upon the parts once a day or oftener. Morphia may be combined with the iodoform. The mercuric nitrate should be carefully applied with a minute fragment of sponge securely attached to a holder, or with the point of a delicate brush. Contact with the ulceration should be positive and momentary, and withdrawal quick. The agent is not safe in the hands of an inexperienced manipulator.

ABSCESS OF THE LARYNX.

Abscess of the larynx may be *intra-laryngeal* or *peri-laryngeal*. One variety of the latter form, confined to the posterior surface, is sometimes mentioned as *retro-laryngeal*. Laryngeal abscess is usually a secondary affection, most frequently a result of perichondritis. Primary circumscribed abscess is infrequent. As determining causes may be mentioned, phlegmonous and traumatic laryngitis, tuberculosis, syphilis, glanders, smallpox, measles, typhus and enteric fevers, and pyæmia. Abscess of the larynx in enteric fever, appears to be much more frequent on the Continent of Europe than in America. The inferior laryngeal face of the epiglottis, the internal face of an arytenoid cartilage, and the ventricular band, are the most frequent seats of circumscribed abscess not the result of injury; but abscess has likewise been noted over the supra-arytenoid cartilages, and on the internal face of the aryteno-epiglottic and the inter-arytenoid folds. When not the result of perichondritis, these abscesses are attributed to inflammation of the submucous tissue and the mucous glands at those localities. Exceptionally, an intra-laryngeal abscess points externally. The pus discharged is usually sanious. The amount is rarely large, but Navratil¹ mentions an abscess of the right ventricle which discharged an ounce of blood and pus spontaneously on the sixteenth day of the disease.

Symptoms.—The local symptoms are pain, dysphonia or aphonia, cough; dyspnoea, and dysphagia. When at all large, the dyspnoea may become extreme, and even suffocation may be threatened.

Diagnosis.—In intra-laryngeal abscess the diagnosis rests almost entirely upon laryngoscopic inspection. The collateral inflammation is sometimes so great as to prevent detection of the abscess; but usually it can be recognized as a glistening, circumscribed tumefaction, red at the base, and red or yellowish at the apex. (Fig. 1148.) It is liable to be confounded with œdema. Partial or complete ankylosis of the arytenoid cartilage is often noted in cases due to perichondritis of the cricoid and arytenoid cartilages. In the absence of laryngoscopic inspection, circumscribed pain alone may indicate the existence of an abscess.

Peri-laryngeal abscess is indicated by peri-laryngeal tumefaction with fluctuation on pressure.

Prognosis.—The prognosis is favorable in intra-laryngeal abscess, if the diagnosis has been made; as measures can be instituted at once to avert any

Fig. 1148.



Abscess from perichondritis of arytenoid cartilage.

¹ Laryngologische Beiträge, S. 20. 1871.

risk of death by suffocation. Death has occurred in this way both by the abscess itself and by collateral œdema; but, in the cases recorded, the nature of the affection had not been made out during life. Spontaneous discharge often ensues; the contents being ejected by cough, with immediate relief to the subjective symptoms. The ultimate prognosis depends upon the nature of the disease or injury which has given rise to the abscess. In some instances, a second abscess will be developed within a week or two after the discharge of the first; and this may be followed by one or two more at intervals of several weeks or of several months. Stenosis of the larynx is an occasional sequel of abscess. In peri-laryngeal abscess the prognosis is dependent upon the nature of the disease which has occasioned it.

Treatment.—Under favorable circumstances, an intra-laryngeal abscess can be punctured or incised with a properly curved knife, guided by laryngoscopy. Should this operation be impracticable, a precautionary tracheotomy will be indicated under conditions of dyspnoea threatening death by suffocation.

Peri-laryngeal abscess is treated by incision at the most accessible point, as far as practicable in the middle line.

PERICHONDRITIS AND CHONDRITIS.

As far as is known, chondritis is always preceded by perichondritis. Perichondritis is commonly deuteropathic or traumatic in origin. Primary perichondritis, usually attributed to great exposure to cold and moisture, and occasionally to over use of the voice, is very rare. Even cases supposed to have been of this nature have eventually proved to be deuteropathic.¹ It occurs much the most frequently in tuberculosis; and to a less extent in syphilis, typhus and enteric fevers, variola, diphtheria, scarlatina, lupus, pyæmia, carcinoma, and traumatism. Occasionally it is a direct sequel of protracted chronic laryngitis. Except in cases occurring in enteric fever, when adolescents and young adults are most liable, it is more frequent in adults than in children, and most frequent between the ages of twenty-five and forty. In enteric fever the process rarely begins before the second week; but it may not be noticed until the period of convalescence. Some authors attribute perichondritis to ulceration progressing from the mucous membrane. Others attribute this ulceration to precedent perichondritis. The conclusion is that inflammatory processes may originate in the perichondrium, or be a result of transmission by contiguity. The cricoid and arytenoid cartilages are the most frequent sites of the process—the former in its posterior segment especially—a fact unsatisfactorily accounted for by its dependent position in recumbency, and its pressure against the vertebræ, as claimed by some observers. The thyroid cartilage is attacked far less frequently, and the epiglottis only exceptionally. Suppurative inflammation soon loosens the perichondrium from the cartilage, which then undergoes necrosis from innutrition, without actual inflammation. The suppurative process develops an abscess which breaks through the superjacent soft tissues, sometimes externally, oftener internally, and then the necrosed cartilages are often discharged—in detritus, in fragments, or in bulk, as may be. Intercurrent infiltration of the intra-laryngeal soft tissues may produce acute stricture; and should the process eventuate in permanent hyperplasia, whether of soft tissues or of cartilage, chronic stricture or stenosis may result. In tuberculosis and even in typhosis,² the arytenoid cartilages are frequently discharged entire.

¹ Hall, Brit. Med. Journal, May 6, 1882, p. 660; and April 26, 1884, p. 814.

² Chvostek, Centralblatt für die med. Wissenschaften, No. 11, 30 Dec. 1883.

Similar exfoliation of the cricoid has been reported by Hunter,¹ and by myself.²

A very circuitous route to the exterior is sometimes taken. Thus an abscess, originating at the posterior portion of the cricoid, may point in the pre-thyroid region.³ Fistula often results, and extensive emphysema may thereby ensue. Durham reports an instance⁴ in which the emphysema was more extensive and general than in any other case of any kind which had come under his observation.

Perichondritis of the thyroid cartilage, suppurating with pointing of the abscess externally, sometimes occurs independently of disease of the interior of the larynx. In an instance noted by Dr. Gibb,⁵ the pus had a peculiar blue color.

Symptoms.—The symptoms are much the same as those of severe acute or chronic laryngitis, with pain, elicitable on pressure externally, and sometimes in deglutition and in phonation. Should the disease progress, hoarseness, cough, and dysphagia soon occur; then dyspnoea, perhaps, with stridulous respiration or paroxysmal apnoea; and eventually symptoms of stricture. Discharge of the abscess excites cough and expectoration, followed by great subsidence in the local distress. Should fragments of cartilage become lodged in the clink of the glottis, suffocative apnoea may ensue.

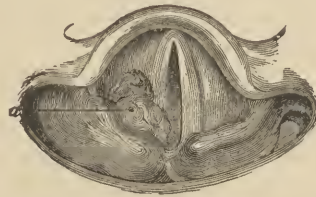
Diagnosis.—The location of the pain, whether spontaneous or elicited by palpation, often indicates which cartilage is affected. Laryngoscopic inspection reveals local tumefaction or abscess in the domain of the diseased cartilages. Perichondritis of the cricoid will be indicated by swelling beneath the vocal bands, sometimes posteriorly, and sometimes at the side. (Fig. 1149.) When an arytenoid cartilage is involved, the abscess points above the vocal bands—as it does sometimes when both cartilages are implicated. (Fig. 1150.) Sometimes the collateral œdema is so great as to obscure the characteristic tumefaction. Arytenoidal disease is usually indicated further by

Fig. 1149.



Primary perichondritis of cricoid cartilage (Tuerck.)
a, inner wall of abscess.

Fig. 1150.



Perichondritis of cricoid cartilage, with loss of arytenoid, in enteric fever. (Tuerck.) a, wall of abscess.

lack of movement of the corresponding vocal band, or by actual ankylosis of the crico-arytenoid articulation. After discharge of an abscess, a probe can sometimes be brought into contact with necrosed cartilage. Perichondritis of the thyroid cartilage often produces swelling externally, through which the denuded cartilage may be detected with an exploring needle.

Prognosis.—While the prognosis may be favorable in idiopathic or primary

¹ Cited by Rühle (Die Kehlkopf-krankheiten. Berlin, 1861).

² Transactions of the Pathological Society of Philadelphia, p. 148. 1874.

³ Robinson, Am. Jour. Med. Sci., April, 1875, p. 399.

⁴ Op. cit., 3d ed., vol. ii. p. 688. London. 1883.

⁵ Brit. Med. Journal, Dec. 13, 1873, p. 684.

perichondritis, and even in traumatic cases, it is almost always unfavorable in deuteropathic or secondary cases. Few patients recover, and many that survive, suffer with a permanent stricture. Defects in the cartilage are sometimes repaired by connective tissue.

Treatment.—In primary perichondritis, antiphlogistic treatment is indicated; cold should be applied externally, and by frequent deglutition of ice; and the same surgical supervision is required as in other forms of acute laryngitis. At a later period, should the disease continue, the treatment would merge into that to be adopted in deuteropathic cases: namely, the administration of tonics and stimulants, with food by the rectum or stomach-tube, when required; precautionary tracheotomy, to avert suffocative apnoea—tracheotomy is here preferable to laryngotomy; early incision of abscesses; and removal of loose fragments or cartilages. The treatment for strictures, in cases that survive, has been indicated at page 282.

CROUP AND DIPHTHERIA.

From a surgical point of view, the main interest in croup and diphtheria centres in the question of tracheotomy, which may be discussed independently of any consideration as to the identity of the affections. The first successful tracheotomies in modern times, for croup or diphtheria, seem to have been performed shortly before 1730, one of them by Dr. George Martine, who describes¹ a case of croup which, from the healthy appearances of all parts in view, he inferred to be “an angina of the most malignant type (*Angina sine tumore*, of Hippocrates),” and mentions earlier successful operations by Mr. Baxfer and Dr. Oliphant. Two objects are attainable by this operation: first, the removal of false membrane through the wound, and second, the establishment of a tract for respiration below the point of obstruction. Should the obstruction be in the bronchi, but little benefit can be anticipated. The proper moment for surgical interference, a matter of serious import, has long been a subject of debate. Performed too early, tracheotomy may expose the patient to unnecessary peril; performed too late, it may be worse than useless. Yet it may be safely stated that there are no positive contra-indications to the procedure, save evidence of accumulations of fibrin in the cavities of the heart. Here death by syncope is inevitable, and the knife can afford no relief to the cardiac obstruction. Continuous and increasing dyspnoea of mechanical origin, at any stage of the disease, which resists the influence of less radical measures, is indicative of obstruction to respiration, sufficient to justify the operation. Little is to be gained by waiting, and much may be sacrificed.

Two sets of symptoms occur, dependent upon the location of the obstruction. In one, the dyspnoea is continuous and progressive, but there are no violent struggles for breath; air reaches the lungs, though in restricted areas. There is no inspiratory depression of the soft tissues above the sternum, and but little, if any, below the diaphragm. The respirations are frequent and shallow; the pulse is small and frequent; the skin is livid, cold, and perspiring; the face is swollen; the eyes are listless and their pupils dilated; the finger tips are blue at the nails; the mucous membrane within the mouth is pale; sensation is dulled. False membrane occupies the bronchial tract, plugging some passages and obstructing others, so that air

¹ Philosophical Transactions, vol. vii. No. 416, p. 448. 1719-1733; cited in a private letter from Dr. John R. Quinan, Baltimore, Nov. 23, 1883. See also Quinan, Maryland Medical Journal, Dec. 1, 1883, p. 512.

cannot reach the pulmonary vesicles in quantity sufficient to maintain the interchange essential to due hæmatosis. This form of apnœa is regarded by many as a contra-indication to tracheotomy, although the operation has occasionally saved life even when the symptoms have been at their worst. The other set of symptoms attends more rapid suffocation, with paroxysmal apnœa. The agitation is great; orthopnœa is marked; the struggles for breath are intense; the sub-thoracic tissues are deeply indented with each inspiration, and, at a later stage, the supra-sternal tissues likewise; inspiration is noisy and stridulous; the pulse is small and quick; the cervical veins are swollen; the face is turgid, flushed at first and subsequently cyanosed; the eyes are suffused and prominent; the skin is warm and moist; the mucous membranes are blue; the vesicular murmur is faint or absent. The false membrane occupies the larynx, or the larynx and trachea. These cases are considered favorable for tracheotomy; and on its performance the morbid respiratory phenomena subside. The presence of pseudo-membrane is not the only indication for operation. Whether false membrane be present or not, recurring spasmodic constriction of the glottis, or paralysis of the dilating muscles, may threaten suffocation, avertible only by tracheotomy.

In a study made by me, in 1873,¹ of more than five thousand operations for croup and diphtheria, it became apparent that about one case in four recovered after tracheotomy, although several series of individual statistics presented much more favorable results. Thus a few meagre records may be cited in which all patients were saved—two each by Buck, Cabot, and Balassa; and a number in which more than one-half were saved, as the 6 out of 7 by Schoellhammer; 3 out of 4 by Baudin; 8 out of 11 by Cruickshank; 4 out of 6 by Gerdy and Bardinet; 2 out of 3 by Perrochaud; 6 out of 9 by Cheever; 11 out of 17 by Von Köpl; 10 out of 16 by Bourdillat; 3 out of 5 by Moynier; 5 out of 9 by Petel and by Richet; and 13 out of 23 by Calvet. The figures are reproduced to show that combinations of circumstances may produce unusually good results, and that no hard and fast rule can be deduced from mere statistics. A favorable age in the patient, a judicious selection of cases, a happy recognition of the proper moment for surgical interference, skilful operation and assiduous attention afterwards, may have formed the combination productive of this exceptional experience. There is no reason to believe that any of these tracheotomies were needlessly performed, or that unusual success was due to luck.

The proportions of recoveries at the hands of these operators may have been increased by subsequent operations. Most likely they have been diminished; as several series have had to be dropped from my original list² for this cause.

Indeed, personal inquiry has convinced me that particularly brilliant series of successes are rarely maintained for long terms of years. Thus an enthusiastic advocate of the operation in Philadelphia, who had saved three out of the four children upon whom he had performed the operation up to the time alluded to, informed me a few years afterwards that he had done seven tracheotomies since then, and had lost every case. His successes had fallen from 3 in 4, to 3 in 11. A physician in New York, the statistics of whose operations were presented with a record of 13 successes out of 67 operations, told me, some years ago, that after his record had been published he had done more than one hundred unsuccessful operations before he had been able to add another recovery. His successes, then, were temporarily reduced from 13 in 67, to 13 in 167. These illustrations are mentioned, not in discouragement of the operation, but in deprecation of extravagant claims for it.

¹ Croup, in its relations to Tracheotomy. Philadelphia, 1874.

² Op. cit., p. 26.

It is neither to be regarded as a routine procedure nor as a last resort. It is a legitimate therapeutic measure, with a definite purpose. The special indication cannot be formulated by an inflexible rule. The good judgment of the surgeon must be his guide. The most favorable moment for interference, is when the surgeon begins to think that the patient cannot live without it; but recovery follows occasionally, even when the operation has been postponed until immediately after apparent death.

Comparatively few children under two years of age are saved, not many over eight or nine, and adults only as the exception. The adult larynx is so large that it rarely becomes at all occluded in diphtheria, until such a late date that fatal blood-poisoning has occurred in the normal progress of the disease.

That operations are by no means hopeless at the earlier age referred to, the following record, amended from my own essay,¹ will abundantly testify. Thus successes are reported at six weeks by Scoutetten; at three months by Annandale;² at five months by Croft;³ at six months by Kisler;⁴ at seven months by Bell, Tait, and at Langenbeck's clinic;⁵ at eight months by Elias;⁶ at nine months by Steinmayer;⁷ at ten months by Baizeau, Dujardin, Bourdillat, Foster, Greenfield,⁸ Elias, and Winiwarer; at 11 months by Shradz;⁹ and in a case operated upon at the Boston City Hospital;¹⁰ at 13 months by Trousseau, Barthez, and Archambault; at 14 months by Millard and Henry;¹¹ at 15 months by Baizeau and a colleague of his; at 16 months by Isambert and Potain; at 17 months by von Vigla and Jacobson;¹² at 18 months by Moutard-Martin, Potain, and Archambault; at 19 months by Pancoast; at 21 months by Sandler, Waren Tay,¹³ and Mayer;¹⁴ at 22 months by Labord, Isambert, and Parker;¹⁵ and at 23 months by Labord and Malshieurat-Le-grand.

On the other hand, I have been unable to find more than three successes recorded in adults; 1 by Quain;¹⁶ 1 by Lloyd,¹⁷ and 1 by Nussbaum.¹⁸

The successful completion of the operation does not terminate the surgeon's responsibility. He must protect his patient from suffocation, which is liable to ensue by occlusion of the artificial opening just made. First of all, he must search the air-passages for pseudo-membrane, just as he would were they obstructed by any other foreign body. The edges of the incision being held apart, by hooks, ligatures, or simple or special retractors—of which the retractor devised by Mr. Golding-Bird (Fig. 1129, p. 272) is probably the best—forceps are to be introduced, to search for false membrane and extract it. For obvious reasons the first search is made below the wound, and the larynx is explored afterwards. Suction at the wound with the mouth, is probably the most efficacious method of withdrawing fragments of pseudo-membrane, but it is not safe. Infection and death therefrom may follow. More than one surgeon has sacrificed his life in this manner, and has failed to save his patient.

¹ Op. cit., p. 24.

² The child lived seven weeks. *Edinburgh Medical Journal*, p. 1121. 1862.

³ *Lancet*, November, 1880, p. 849.

⁴ *Deutsche med. Woch.*, No. 45. 1878.

⁵ Krönlein, *Arch. f. klin. Chir.*, Bd. xxi. S. 253. Eighty-five operations in children under two years, with eleven recoveries, one at seven months.

⁶ *Deutsche med. Woch.*, No. 45. 1878.

⁷ *Berliner klin. Woch.*, No. 20. 1880.

⁸ Saint Thomas's Hospital Reports, vol. viii. p. 261. 1878.

⁹ *Medical Record*, November 4, 1882, p. 512.

¹⁰ *Gay, Medical News*, July 12, 1884, p. 33.

¹¹ *Journ. de Thérap.*, Août, 1874, p. 561.

¹² *Medical Record*, June 30, 1883, p. 705.

¹³ *British Medical Journal*, September 16, 1882, p. 523.

¹⁴ *Medical Record*, April 26, 1884, p. 457.

¹⁵ Saint Bartholomew's Hospital Reports, vol. xviii. p. 323. 1882.

¹⁶ Jenner, *Diphtheria, its Symptoms and Treatment*. London, 1861.

¹⁷ *British Medical Journal*, October 16, 1875, p. 513.

¹⁸ Werder, *Pittsburg Medical Journal*, February, 1883, p. 46. The operation was undertaken after apparent death, and artificial respiration was maintained for fifteen minutes.

Suction with a syringe, the nozzle of which has been encircled at a convenient point with a section of rubber tubing just thick enough to fill the incision nicely, is an admirable substitute for suction by the mouth, the risk from which is unjustifiable, even though performed through the medium of a catheter with a globular offset at the side, to catch the matters withdrawn and thus protect the mouth. A flexible catheter may be attached to the nozzle of the syringe, and may be introduced into the trachea after reinforcement with rubber tubing to occlude the artificial orifice. On drawing the piston of the syringe, fragments in contact with the eyes of the catheter are apt to become engaged therein, and may thus be readily withdrawn. Furthermore, the cough which is excited sometimes drives obstructing products through the artificial opening. It is desirable to explore each primitive bronchus in turn. This surgical clearance is far preferable to the slow clearance following the usual dependence upon nature's unaided efforts. It adds little local irritation, if any, and diminishes the sources of exhaustion. Re-accumulations of pseudo-membrane, resisting voluntary expulsion by cough, should be subjected at intervals to gentle manipulations of the same kind. Even the mere introduction of an elastic catheter sometimes excites expulsive cough with discharge of membrane, blood, and mucus. Foreign products having been withdrawn, the question arises as to the best method of keeping the artificial opening patulous. If the surgeon, or an equally responsible and efficient substitute, will remain by the patient for a few hours, the retractors may be retained in position without any attempt to introduce the canula. This practice will facilitate expulsion of membranes, a process always impeded to some extent by a tube in the trachea, the presence of which renders it necessary that any matters expelled shall be driven through it. Thus many ineffectual paroxysms of coughing, often exhausting to the patient, precede the successful one which gives relief. In a few hours, however, the permanent method of keeping the trachea open is to be decided on. In most instances, the delay recommended above is not made, but the permanent arrangements closely follow the operation. They depend somewhat on the character of the operative procedure which has been adopted. The operation in frequent practice is longitudinal incision of the trachea in the median line, for a distance comprising three interspaces or even three rings. Most surgeons incise the trachea as high as possible; others as low as possible. Some divide the cricoid cartilage; others the cricoid cartilage and a ring or more of the trachea. Some excise a portion of the anterior wall of the trachea, the incision being elliptic, oval, rectangular, or diamond-shaped. Some excise the anterior wall of the cricoid cartilage, whether with preservation of its perichondrium or without. Division of the cricoid-thyroid membrane is rarely practised in croup and diphtheria. The majority of operators introduce a rigid, curved tube or canula into the trachea, whether incision or excision has been practised. Some dispense with a tube altogether, and, when excision has not been practised, resort to hooks and ligatures to keep the opening patulous. It would be very desirable to dispense with a tube; but so great is the risk that the orifice in the trachea may become overlaid by the soft parts in some of the movements of the child, especially during sleep, and thus suffocate the patient, that continuous supervision of the opening is essentially requisite. The attention of the best of nurses, trained or domestic, is occasionally unwittingly drawn from the orifice, and, during such inattention, suffocation may take place. It is, therefore, safest to employ a tube.

The operation over, the indications remain for continuing the supporting measures and the anti-diphtheritic medicinal treatment already adopted. Tracheotomy saves a patient from death by suffocation. It does not cure the disease. [See remarks on Intubation of the Larynx, page 388, *infra*.]

AFTER-TREATMENT IN CASES OF TRACHEOTOMY FOR CROUP OR DIPHTHERIA.—Much of the success in tracheotomy for croup and diphtheria, depends upon the efficiency of the treatment after the operation. Much of the want of success previous to 1850, or thereabout, was due to lack of recognition of this fact. The operation and the subsequent manipulations being completed, the patient should be put to bed in an apartment at a temperature of not less than 70° F.; for a certain amount of chilliness usually ensues, often proportionate to the amount of hemorrhage during the operation, and to the intensity of the dyspnœa before it. The external opening should be covered with a fold of woollen gauze or scarf, straddled upon a tape or a strip of plaster applied above the wound. This protects the trachea from dust, and warms the air a little, as it is inhaled. The risk of pneumonia is thereby lessened, and the liability diminished to clogging of the tube by accumulations of desiccated crusts and fragments of false membrane. The atmosphere of the room should be kept moist as well as warm. The evolution of steam in the immediate vicinity of the patient will effectually warm and moisten the air he breathes. In the absence of facilities for making steam, flat sections of sponge wrung out of hot water should be kept over the tube. If reaction from the chill be tardy, warm, aromatic drinks should be administered, and flying sinapisms should be applied to the trunk and limbs. Under their influence, restlessness subsides and sleep ensues. Sleep, indeed, often comes on before the dressings are completed; occasionally on the operating table, as soon as the canula has been inserted. Inhalations of steam and of the vapors of slaking lime are as useful to detach the pseudo-membrane after the operation as before it. Indeed, it deserves especial mention in passing, that I know of no one agent so useful in detaching pseudo-membrane from the larynx and trachea, as copious inspirations of the vapors arising from lime in the process of slaking, as suggested by Dr. Geiger,¹ of Dayton, Ohio. I feel assured that, in my own hands, the remedy has saved a number of children from the necessity of undergoing the operation. Its action seems altogether mechanical, small particles of lime prying up the edges of the partially detached shreds, so that the watery vapor gets under them and accelerates their separation. A small piece of lime in a pail of water is of no use. Several lumps of lime, the size of a small fist, should be placed in a bucket by the side of the bed. Hot water should be poured upon them till they are barely covered. A funnel-shaped hood of newspaper, or a stout paper bag with one corner cut off, should be inverted over the vessel, with the outlet directed towards the patient's mouth. In a few minutes there is a copious evolution of vapors charged with lime, which rush through the orifice and are inhaled. The patient's eyes should be protected from the particles of lime. Cough is excited, and sometimes emesis, and with the cough large quantities of false membrane are expelled, if any have been present. Each inhalation consumes some ten or twelve minutes; and the process is to be repeated at intervals of half an hour, or less frequently according to the indication. Used in this manner, inhalations of lime will disappoint expectation much less frequently than the slaking of one small fragment at a time, or the use of lime-water in spray.

The expectorations are at first mingled with blood which has trickled into the air-passages. They often become mucous, thick, and opaque, sometimes forming large, irregular masses. Sometimes they remain semi-transparent and fluid, though viscid. These are the characteristics of laudable expectoration. The trickling out, without cough, of serous, grayish, fetid and non-aërated products, is an unfavorable prognostic. If there be no cough, the prognosis is bad; for mere drainage is insufficient to prevent gradual apnœa.

¹ Medical and Surgical Reporter, March 24, 1866.

The removal of the pseudo-membrane probably produces some excoriation of epithelium, and it is in part due to the reparative process in that tissue that those discharges take place, which in desiccation form the coriaceous crusts which so often accumulate shortly after the operation. The inspiration of warm and moist air tends to retard this desiccation, and favors the removal of these products by cough. Cough is therefore a good prognostic. When the secretions accumulate in threatening quantity, it is better practice to attempt their mechanical removal by aspiration, than to trust to the uncertain influence of medicinal expectorants.

Traumatic fever is usually manifested within a few hours after the operation, sometimes within an hour. The greater the dyspnoea and hemorrhage have been, the later, as a rule, the febrile reaction. In favorable cases this fever subsides within a day or two. Its persistence indicates some unfavorable complication. Sometimes it is sufficiently violent to prove fatal within twenty-four hours. Should the respirations exceed forty in the minute during sleep, after subsidence of this fever, pneumonia is to be dreaded. A pulse exceeding 160 in the minute, a temperature exceeding 102° F., and a sudden rise in temperature, are likewise indicative of impending complication.

Diarrhœa and vomiting, a few hours after the operation, are to be expected in children to whom ineffective emetics have been given, as the re-establishment of respiration promotes the absorption of drugs already in the alimentary tract; hence the inference that such remedies should not be pushed, when once they have proved ineffective.

The appetite is usually good for two or three days, but then it often becomes poor, usually in advance of some impending complication. Abundant nutrition is necessary. Every effort should be made to give food by the mouth. If the effort to do so fail, food should be given by the stomach-tube and by the rectum. Paralysis of the muscles of the palate, pharynx, and larynx, sometimes supervenes in diphtheria, so that milk and other fluids trickle out by the side of the tube, or enter the trachea and excite cough. Here, again, is an indication for using the stomach-tube and the enema-syringe.

The *care of the canula* is a point of gravest importance. As already mentioned, the tube is liable to become obstructed by expectorated products. If these are not removed, suffocation will ensue. Hence a competent attendant—by preference a judicious medical attendant, familiar with the character of the accidents which may follow tracheotomy—should be at the side of the patient, or within immediate call, until all danger from this source is over. Should the tube become occluded, relief must be immediate. Such occlusion is indicated by restlessness of the patient, and by peculiar moist sounds in respiration; the inner tube should then be removed for cleansing, and the outer tube should be swabbed out with a feather or a soft mop. These manipulations, as well as the replacement of the inner tube, usually excite cough and expectoration of occluding products. Partial or complete occlusion of the outer orifice with the finger, during the explosive movements of the cough, renders that act more effective. Soft, antiseptic sponges or mops should be at hand to catch any discharges which may present themselves externally, and to prevent their being sucked back into the canula. A shred of pseudo-membrane detained at the inner extremity of the tube, produces a characteristic flapping, at times attended with harsh and stridulous respiration; cough is excited, and the membrane is usually ejected after some effort. Should this expulsion be retarded, the inner tube should be removed; and if the membrane be not then driven through the outer one, attempts should be made to catch it with curved forceps. Should these fail, cough should be excited by passing a feather or delicate mop through the tube into the trachea. Should this too fail, a few minims of water should be passed, drop by drop, and the instilla-

tion be repeated at intervals of a few minutes. This failing, aspiration should be made with the catheter and syringe. If the obstruction resist all these measures, the outer canula should be removed, when the membrane will probably be coughed through the unobstructed orifice. The removal of the canula, especially during the first twenty-four hours, necessitates a skilled hand for its re-introduction. When it cannot be replaced, or when its presence prevents expulsion of obstructing products, some other method of keeping the orifice open must be employed. Here the dilating retractor of Golding-Bird will again be of great use. Hooks may be improvised from hair-pins, and may be held in position by tapes passing around the neck. Skilled judgment is necessary for the recognition of these important points, and for their proper management. An officious nurse may interfere unnecessarily on the one hand, and do injury on the other. The obstructed character of the respiration is the guide for interference. Under all circumstances, the condition of the inner canula should be observed every two or three hours, to clear it of any viscid secretions that may have adhered to it; and these should be carefully examined in water, so as to detect membranes, which will float out in flat pieces, their amount indicating how the case is progressing.

Changing the Canula.—At the end of twenty-four hours, or thereabouts, the canula, soiled as it is with blood and sputum, should be removed for cleansing, and be replaced by a clean one. It is best to do this by daylight, and with the child in the same position as when it was inserted. This removal is followed by cough and discharge of morbid products. The tube being removed, the parts are to be carefully inspected and carefully cleansed. If everything has gone on well, the tube, if of silver, though soiled by mucus, pus, and blood, will not be tarnished. If blackened, mortification is indicated at the corresponding point of the wound. If the tissues are healthy, the parts will be normal in color, and soft; and the edges of the wound will be everted. Sometimes the parts will be so pliable as to turn inward and occlude the tracheal incision. Then a dilator should be introduced to keep the wound open until a tube is inserted. Meanwhile, if indicated, search may be made for false membrane. The canula should be changed once a day, and the wound dressed if need be. When air begins to pass by the natural passage, as tested by covering the external wound with the finger-tip, the tube may be left out for a few minutes at each dressing, to be replaced immediately should respiration become embarrassed. From day to day the tube may be dispensed with for increasing intervals, until it is finally put aside. One of the most favorable indications for this procedure is expectoration by the mouth.

Definitive Removal of the Canula.—Usually practicable from the fifth to the ninth day, this may not be feasible for many weeks. Some series of observations are remarkable. Thus in a series of fifteen successful cases recorded by Max Müller,¹ the tube was not definitively removed in thirteen until the 13th, 15th, 25th, 27th, 44th, 45th, 51st, 69th, 70th, 105th, 112th, 120th, and 203d days respectively. In a series of eighteen cases recorded by Steiner,² the tube was removed on the 10th day in two cases, on the 17th in 1, 20th in 3, 21st in 2, 25th in 2, 28th in 4, 30th in 1, 35th in 1, and in the remaining cases not until the end of fifteen months. Sanné³ gives a series of 108 cases, in 65 of which the tube was removed before the 9th day, and in one instance at the end of the first day; from the 9th to the 25th in 37 cases; from the 30th to the 45th, in 5 cases; and in 1 case on the 126th day.

¹ Archiv für klin. Chirurgie, S. 448. 1871.

² Jahrbuch der Kinderheilkunde, No. 1. 1868.

³ Étude sur le croup après la trachéotomie. Paris, 1869.

The causes preventing early, definitive withdrawal of the canula, are inflammatory tumefaction, spasm, and diphtheritic paralysis. Prolonged retention is, in most cases, due to fungous excrescences in the track of the wound, or on the internal surface of the air-passages. These are often the direct result of irritation by the edges of a fenestrum in the upper portion of the outer tube, so placed, in the great majority of instances, as to open upon the track of the fistula in the soft tissues exterior to the air-passages, instead of being wholly within the air-tube. Practically the fenestrum is useless, for no tube should be used large enough to fill the calibre of the air-passage, or to prevent a sufficient current of air from passing outside for purposes of phonation.

The canula having been removed, the remaining fistula should be allowed to contract of itself, the part being simply protected from access of dust by a little apron of muslin straddled on an adhesive strip, or a tape, above it. If undisturbed, the cicatrization is usually complete in two or three days, sometimes in less than forty-eight hours. When cicatrization progresses satisfactorily, the prognosis is favorable as to ultimate recovery. Delay indicates some impending complication, usually pneumonia, an exanthem, or paralysis.

The casualties which prevent recovery after tracheotomy for croup or diphtheria arise from two sources. Those of one set are incident to the disease, and those of the other to the operation. The first will be merely mentioned. They comprise extension of the pseudo-membrane, systemic infection, paralysis, nephritis, pneumonia, and heart-clot. The accidents of the second class comprise hemorrhage (primary and secondary), emphysema, inflammation of the track of the incision, erysipelas, abscess, gangrene, diphtheria of the wound, ulceration of the trachea, and pneumonia. Some of these need special comment.

Hemorrhage may result from division of a vessel during the operation, from manipulation in dressing the parts, from ulceration by pressure of the canula, or from vascularity of the delicate granulations in the track of the wound. Compression against the tube is the best treatment, small pieces of absorbent cotton being placed above the incision, one on top of another, as required. It is dangerous to remove the canula and search for the bleeding vessel. Alcohol and ergot may be administered internally. Inflammation of the wound and of the parts around it, occurs more frequently in tissues over which a fine gum cloth or piece of oiled silk has been used as a dressing, vesication taking place under the dressing in consequence of detention there of the secretions and discharges. Hence it may be avoided to some extent by rejecting such dressings. The swelling may be so great as to necessitate removal of the original tube and its replacement by a longer one, to reach the interior of the air-passage.

Emphysema is usually caused by an unskilful operation; most frequently by denudation of the peri-tracheal fascia in rough endeavors to introduce a tube; less frequently by faulty incisions. If limited to the vicinity of the wound, it is practically unimportant. If extensive—and it is sometimes very extensive—it may force the tube out of the trachea, and necessitate the substitution of a longer one. It usually disappears within a day or two. Occasionally it lasts more than a week. If due to the use of too short a tube, a longer one must be introduced, or a catheter substituted for it, the edges of the tracheal wound being kept asunder by dilator, forceps, blunt hooks, bent hair-pins, ligatures, or whatever device may be at hand. Much of the air in the vicinity of the wound can be expelled by gentle friction towards it. Sometimes it may be necessary to puncture the skin at a few points.

Ulceration of the trachea by attrition of the canula may be superficial, or may be so deep as to expose the cartilages or even penetrate the trachea. It is due to illy fitting tubes. It is most frequent anteriorly, sometimes

occurs posteriorly only, and occasionally exists in both directions. The innominate artery has been known to be opened by ulceration of this kind. Frequent inspection of the canula will discover blood or tarnish at its extremity, if it is producing ulceration; while cough, and pain referred to one spot, will constitute the subjective indications. Change in the length and shape of the canula is the preventive remedy.

BRONCHOTOMY: LARYNGOTOMY, TRACHEOTOMY, ETC.

BRONCHOTOMY.—*Bronchotomy*, literally a division of the windpipe, is the generic term long applied to incisions made into any portion of the air-passages, although a wound of a bronchus has never been included in the category—the word *bronchus* having been used by the ancients to designate the trachea, and the word *bronchia* its ramifications.

As their names imply, *laryngotomy* and *tracheotomy* denote incisions into the larynx and into the trachea; and *laryngo-tracheotomy*, a continuous incision involving both structures. They are performed to secure artificial openings for several purposes, namely, the re-establishment of respiration when the normal channel is occluded above; the removal of foreign bodies, whether of pathological origin or of accidental introduction; and the extirpation or destruction of morbid growths. They are performed in the middle line, except when unusual conditions compel a lateral incision.¹

Laryngectomy is an exsection of the larynx, whether partial or complete. It is sometimes associated, in either instance, with exsection of adjacent structures. It is occasionally performed in certain cases of irremediable malignant disease of the larynx, usually sarcoma or carcinoma. A limited partial laryngectomy, termed *resection of the larynx*, is sometimes performed in stricture of this part, to remove cicatricial and other indurated tissue.

Laryngotomy may be complete or partial. Complete laryngotomy implies section of the thyroid and cricoid cartilages and the intervening crico-thyroid membrane. It is rarely performed, and usually only in removals of extensive intra-laryngeal morbid growths, or as a step preliminary to possible laryngectomy. Section of the thyroid cartilage, *thyrotomy* or *thyroidotomy*, is usually performed for the purpose of removing morbid growths unsuitable for operations by the natural opening, and for gaining access to foreign bodies imprisoned in the upper portion of the larynx, especially when the intruders are caught in one or both ventricles. Section of the crico-thyroid membrane, *crico-thyroid laryngotomy*, *crico-thyrotomy*, or *intercrico-thyrotomy*—a meso-chondric operation—is usually performed in cases of occlusion of the upper portion of the larynx from acute disease, in which the artificial opening is needed but for a few hours, or a few days; or for access to minute morbid growths upon the vocal bands or beneath them. It is occasionally performed for access to a foreign body in the larynx. It is the operation until recently most generally known as laryngotomy. Being by far the easiest and least dangerous operation of the entire series, it is often performed upon a sudden and sharp emergency, or when the operator has no assistant at hand. It is rarely performed upon children for any purpose. When the opening which it gives is insufficient, it is customary to prolong the incision a slight distance into the thyroid cartilage, or to sever the cricoid cartilage.

Section of the thyro-hyoid ligament—*sub-hyoid pharyngotomy*, sometimes

¹ Lateral incisions into the trachea were recommended by Quain (*Elements of Anatomy*. London, 1829; cited by Gross, *op. cit.*, p. 234), and were practised several times for the extraction of foreign bodies by Gilbert, of Philadelphia (*Am. Journ. Med. Sci.*, N. S. vol. xxi. p. 74, 1851).

incorrectly called *sub-hyoid laryngotomy*—exposes the upper aperture of the larynx, especially if the epiglottis be drawn out through the wound. It is occasionally performed to extirpate a morbid growth, or to remove a foreign body. Sometimes it is performed in desperation in an emergency, when suffocation is imminent from inflammatory tumefaction or other obstruction at the top of the air-passage. It is the usual cut of the suicide. It accomplishes the main object of giving air to the lungs, but is not an operation of election.

TRACHEOTOMY, the chief operation of the series, is practised for the removal of foreign bodies from the air-passages; for giving air in inflammatory occlusions, acute or chronic, above the points of election; for croup and diphtheria; and as a prophylactic measure permitting temporary tamponning of the trachea during bloody operations upon the mouth and face. There are two points of election in tracheotomy, the one above the thyroid gland and the other below it. The choice is governed by the purpose for which the operation is to be performed. Incisions at these localities are known respectively as the high and the low operation. Sometimes the election cannot be made, and the incision must be made right through the gland. Although direct section of the gland is often done with impunity, the well-known vascularity of its structure naturally indicates the propriety of securing it between two ligatures before it is divided. The high operation is performed by most surgeons in cases of croup and diphtheria, as being the easier of execution, and the less liable to complication by hemorrhage. Nevertheless, from choice or habit, some operators, myself among them, almost invariably perform the low operation. The low operation, which permits the use of a tube of large calibre, is to be preferred in all instances of irremediable and other serious disease of the larynx, in which the artificial opening has to be kept patent permanently or for a long time; because the resulting wound is less liable to implication by extension of morbid processes. The same argument holds good, to a certain extent, even in diphtheria. The low incision is also to be preferred in case of impaction of a foreign body in a bronchus.

Tracheotomy is to be preferred to the meso-chondric operation, or to laryngotomy, in all cases in which a tube has to be worn for a long time; as it avoids interference with the functional exercise of the vocal bands on the one hand, and impairment of the solidity of the larynx on the other. So suddenly and urgently does the need for immediate tracheotomy occasionally present itself, that every practitioner should become sufficiently familiar with the details of the operation to be able to perform it in an emergency. Being the most important operation of the series of incisions into the air-passage, its description will embrace many features common to all. The special points of the remainder can be mentioned afterwards. Preceding this description, several considerations demand attention.

When, after prolonged dyspnoea from obstruction of the air-passage, that passage is opened by an incision, the sudden entrance of a large volume of air seems to surprise the lungs, as it were, and there ensues a *momentary arrest of respiration*, which may be mistaken for its cessation. Familiar as this becomes to the experienced operator, it is a surprise to the novice, and may fill him with dread lest he should lose his patient at the very moment of saving life.

The question of *anæsthesia* in these operations is an important one. Much as it facilitates the execution of the operation, my own opinion is that it should be avoided whenever practicable, especially in the presence of great obstruction to breathing. With a few exceptions, it has not been used by myself for many years, even in children. Recovery is better when it has not been used, and imminent immediate dangers are avoided. It is often im-

portant to have consciousness retained, so that the patient can cough and expectorate voluntarily, or take a deep inspiration when so commanded. This advantage, which may avert death by suffocation, is lost when an anæsthetic is given.

Chloroform is preferable to ether, even in the adult, because it is less likely to induce vomiting, and thus possibly lead to inundation of the air-passages, and because it is less irritating to the mucous membrane. Ether, being inflammable, must not be used in operations by ordinary artificial light close at hand, nor in operations performed with the incandescent cautery. In children poisoned by carbonic acid from insufficient aëration of the blood, in croup and diphtheria, anæsthesia often exists to such an extent that the knife is not felt. In some instances, though the cut be felt, the infant budges but little; as if it appreciated the nature of the steps being taken for its relief. Should an anæsthetic be administered, it need be pushed no farther than the induction of unconsciousness, or the abolition of cutaneous sensibility.

When an anæsthetic is withheld from children, the limbs and trunk should be carefully secured in a large towel or a sheet, to control struggles which would embarrass the operator. Adults can usually be coaxed to go without an anæsthetic, especially when they are told that but little pain ensues after the skin has been cut, and that this part of the operation can be done in a second. The pain will be still less if the parts be frozen with ice and salt, or with spray of ether or of rhigolene; and this may be done sometimes, as a compromise. Union, however, is much more tardy when the tissues have been frozen.

The occasion is sometimes presented for immediate tracheotomy, though neither surgical instruments, nor appliances for keeping the wound patulous, be at hand. The trachea or the crico-thyroid membrane may then justifiably be penetrated by one thrust of pocket-knife or scissors, and the instrument may be turned around in the wound, so as to keep the edges apart until assistance can be had to complete arrangements for the patient's safety.

In performing these operations, the patient may be recumbent or semi-recumbent. The latter position is often preferable in the adult, especially when the dyspnoea is intense. Should the recumbent position be selected, the shoulders are to be elevated, and the head is to be allowed to hang back a little, supported by a firm, cylindrical compress, or cushion, under the neck, such as can be improvised by rolling a towel around a wine-bottle or rolling-pin. The object is to render the larynx and trachea sufficiently prominent to facilitate the steps of the operation, without forcing the head back so far as to embarrass respiration by compressing the trachea upon the vertebræ. Some operators stand at the head of the patient, and cut towards themselves; the advantages being a better view of the inferior portions of the wound, and less liability to have the blood and mucus spattered in the face. Others stand at the side of the patient, and cut from above downward. The advantage here is that the normal relations of parts are more easily kept in mind. In operating in the semi-recumbent position, which I prefer, because it approximates the position of the parts maintained by the invalid during the greater portion of his time, the head is bent gently backward over the top of the chair, and the chair is then tilted back a little and maintained in position by supports. The operator may stand at the head of the patient, but when the operation is likely to be a prolonged one, as in the extirpation of morbid growths, it will be better for him to kneel upon a cushion at the patient's side. A reflector is useful at times to facilitate illumination of obscure portions of the field of operation. Operations with the head thrown entirely back beyond the operating bed or table (Rose's method),¹ are sometimes performed to prevent

¹ Arch. f. klin. Chir., Bd. xvii. S. 454. 1874.

blood from flowing down the air-passage. The head is to be supported in the two hands of an attendant, who kneels on a cushion in front of the operating table; the mouth must be kept open by a speculum or dilator, and the tongue be held up with blunt forceps so that it shall not cover the palate and thereby impede respiration. The operator takes a seat in front of the patient's head, and operates by reversed incisions.

Unwarrantable dread of hemorrhage has led a number of practitioners to substitute the incandescent cautery for the knife in making their way down to the air-tube. Thus, some have used the potential cautery,¹ and others the electro-caustic knife,² the electro-caustic loop,³ or the thermo-cautery.⁴ Furthermore, Dujardin used a caustic paste,⁵ Chassaignac employed the *érasateur*,⁶ and Guérin proposed a subcutaneous tracheotomy.⁷ On the other hand, so little dread of hemorrhage is felt by some operators, that they transfix the parts and plunge the knife into the windpipe, right through all the coverings, and divide all the tissues in a single cut; but fatal results sometimes follow this procedure. De Saint Germain claims to have performed tracheotomy by one movement in 227 cases, without a single grave accident due to the operation.⁸ The late Dr. Krishaber, of Paris, informed me, that he regarded this operation as perfectly safe in children under five years of age, in whom he considered the vessels too small to present much danger. It seems to me, however, that in the very cases in which this procedure is most employed—cases of croup and diphtheria—the character of the wound would often prevent that proper search for false membrane which should precede the introduction of a canula, while the dilatation of the wound, necessary in case of accident to hunt for bleeding vessels, would render the entire operation much more serious than a deliberate dissection in the first instance. Similar objections present themselves to the instantaneous use of tracheotomes. Instantaneous tracheotomy, as practised by Chassaignac, Isambert, and others, is performed by fixing the trachea with a grooved tenaculum, secured directly beneath the cricoid cartilage, and then penetrating the windpipe by a direct puncture along the groove, through all the intervening tissue. Though often successful, the posterior wall of the trachea is sometimes severed in the incision. Krishaber employed a knife grooved along the back, so that the escape of air might advise him that its point was within the air-tube.

The following deliberate method of operating seems to me sufficiently rapid for most purposes. Under favorable conditions I have frequently completed the procedure within three minutes, but complications occasionally prolong the operation for half an hour or more.

The patient being placed in position, and his head being steadied by an assistant whose duty it must be to keep it strictly in the middle line, the operator takes his position at the right side of the patient, and the chief assistant at the left. Two methods are employed in making the preliminary incision through the skin and superficial fascia. In the one, the integument is held up in a transverse fold between the otherwise disengaged thumb and forefinger of the operator and his assistant, and is then divided by thrusting a bistoury through its base and cutting from below upward. In the other, which I think preferable, the integument is made tense by spreading the

¹ Le Clere, *Revue Méd.*, 1861; cited by Kühn, in Günther's *Lehre von den blutigen Operationen*, Bd. v. Leipzig und Heidelberg, 1864.

² Verneuil, *Bull. de l'Acad. de Méd.*, p. 299. 1872; *Bull. de Thérap.*, p. 472. 1872; Voltolini, *Berlin. klin. Woch.*, Bd. ix. S. 11; *Lancet*, 1872.

³ Amussat, *Arch. Gén. de Méd.*, Janv. 1873; Tillaux, *Gaz. des Hôp.*, 1874.

⁴ Krishaber, *Annales des Maladies de l'Oreille, du Larynx, etc.* Paris, 1876-7-8; Poincot, *Bull. de la Société de Chirurgie*, t. iii. No. 6; *Lancet*, 1878.

⁵ Kühn, *op. cit.*

⁶ *Med. Times and Gaz.*, 1872.

⁷ *Ibid.*

⁸ *Gaz. des Hôp.*, 5 Janv. 1881; *Medical Record*, March 19, 1881, p. 319.

thumb and forefinger along each side of the trachea, and the incision is then made from above downward. The preliminary incision must be strictly in the middle line, as must be all subsequent incisions. If the hand is not to be trusted, this line of incision should be marked out with pencil or with ink. It should extend from the cricoid cartilage to within a third of an inch of the sternum, and will vary in length with the size of the patient and the swelling of the parts, from an inch and a quarter to two inches. In spare subjects one inch will often suffice. It is highly important that all subsequent incisions be made in the middle line likewise. For this reason the traction kept up on the soft parts should be slight, and equal on the two sides. In certain cases of external tumor, the incisions may have to be more or less to one side. Any wounded arteries having been secured, if necessary, the operator can expeditiously reach the trachea after the following manner, essentially as recommended by Langenbeck: With sharp-toothed forceps he seizes the connective tissue on one side of the middle line, while his assistant does the same thing on the other side. The two then raise the fold of fascia and the operator divides it with knife or scissors. Scissors are very useful for the purpose. In this way fold after fold is severed, large vessels being pushed aside or divided between double ligatures. Both ends of such ligatures should be cut off close, lest they should become detached during the further progress of the operation. The grooved director is preferred by many to forceps as a guide in dividing the layers of fascia. When the pairs of sterno-thyroid and sterno-hyoid muscles are reached, they must be carefully separated, and with as little use of the knife-blade as possible. This having been accomplished, the upper portion of the trachea is exposed, and is usually readily recognizable by its glistening surface.

The isthmus of the thyroid gland, according to its size, covers more or less of this portion of the trachea. If the high incision is to be made, that structure is pulled downward. If the low incision is to be made, it is pushed upward. When these manipulations are insufficient, two strong threads are to be drawn tightly about it, on either side, so that it can be safely divided between them. This precaution is deemed superfluous by some operators, yet copious bleeding is not uncommon when the gland is cut through without it, and even when it is lacerated by tearing it apart. The field of operation is cleansed of blood from time to time in the usual manner. When necessary, the soft parts are kept asunder by blunt hooks on either side. The trachea having been exposed and fully recognized by its anatomical construction, should be freed anteriorly of its enveloping fascia for a space comprising rather more than that to be subjected to incision, and for a line or more in width, in order to avoid all risk of emphysema of the connective tissue by escape of air at the tracheal orifice. This may be done by scraping it with some blunt instrument or even with the blade of the knife. As soon as all bleeding is under control, and sooner if imperatively requisite to avert imminent danger of immediate suffocation, the trachea is to be divided for the space of three or four rings, by thrusting a bistoury vertically into its interior through an inter-cartilaginous space at the median line, and cutting from below upward, a procedure much more prudent than cutting from above downward. Should there be any difficulty in steadying the trachea, it may be held upward by a tenaculum thrust beneath the cricoid cartilage or one of the upper rings. Occasionally strong scissors, or even a saw, may be required to divide stoutly ossified cartilages. As soon as the trachea is penetrated, air escapes with a peculiar hiss, and blood and mucus are expelled by cough as the incision is completed. Sometimes the tracheal mucous membrane is so vascular that the hemorrhage is quite free. The operator now places a forefinger over the artificial opening, insinuating the finger nail into the incision.

He then seizes the edge of the trachea on the distant side with a pair of toothed forceps, closes the slide and hands it over to his assistant, and immediately secures the other edge with a similar instrument which he retains in his own grasp. The two now make slight traction, so as to lift the trachea and separate the edges of the wound, and the air enters without impediment. As already noted, a normal, momentary apnoea may be expected to follow the first deep inspiration. If false membrane or foreign body is to be searched for, the proper manipulations are then to be made. If a canula is to be introduced, the edges of the incision are held asunder sufficiently for the purpose. If the canula is to be worn for a long period, a small, semi-elliptic section should be dissected from each edge of the incision, so as to leave a permanent orifice and thus avoid undue injury to the cartilages by stretching them asunder. Long-continued retention of the canula is almost certain to cause necrotic destruction of the edges of the artificial aperture, and nothing is gained by omitting their excision. When the canula is to be worn but a few days, as in operations for croup, œdema, etc., no such section should be made, as it impairs the integrity of the air-tube after cicatrization, and may lead to internal hernia from atmospheric pressure externally. Should some intra-tracheal operation be requisite, the incision can be kept patent by Golding-Bird's automatic retractor (see Fig. 1129, p. 272), or by some substitutive device.

Simple as tracheotomy is, in some individuals, in others it becomes quite difficult—often from complications presenting themselves as the operation progresses. This is especially the case in children. As bold and experienced a surgeon as Billroth¹ considers tracheotomy in children the most difficult operation that he has ever performed; an opinion which but echoes a similar expression by Gross.² What value then can be assigned to the experience of those who pronounce it “a very simple operation?” While many a tracheotomy is practicable without the necessity of securing a single bloodvessel, the plexus may be so extensive as to require many ligatures. Short necks, superabundance of fat, enlarged thyroid glands, and anomalous distribution of blood-supplies, present much need for cautious manipulation. In such instances, no hesitation should be felt in making as free an incision through the integument as may be desirable to secure proper illumination of the field and ample room for the fingers.

A “bloodless tracheotomy” has been urged by Bose,³ to supersede the ordinary high operation. In this procedure, the first incision is a longitudinal one, extending from the median portion of the thyroid cartilage to about the fourth ring of the trachea. The cricoid cartilage being fully exposed, is then steadied with the finger, and a second incision, rather less than half an inch in length, is made transversely and as close as practicable to the upper margin of the cartilage. This incision, in which the main feature of the operation resides, divides the duplicature of fascia between the cricoid cartilage and the isthmus of the thyroid gland; the *fascia laryngo-thyreoidea* (Hueter). The lower border is seized with forceps, and the fascia stripped from the cricoid cartilage and the trachea with a blunt hook or a director—the isthmus of the gland being gradually loosened from its connections, and pushed downwards and outward, laying the rings bare. The directions of the lines of incision are shown in Fig. 1151.

In cases of emergency, with poor light and without skilled assistants, a rapid tracheotomy is thus executed by Durham.⁴ The patient being put in proper position, a careful preliminary examination of the parts is rapidly

¹ Clinical Surgery, p. 140. London, 1881.

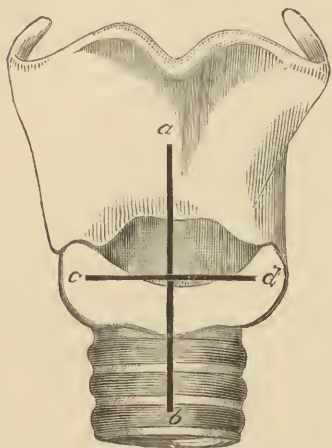
² Archiv für klin. Chir., Bd. xiv. S. 137. 1871.

³ Op. cit., p. 231.

⁴ Op. cit., 3d. ed., vol. i. p. 775.

made. The surgeon then places the forefinger of his left hand on the left side of the trachea, and the thumb on the right, and makes uniform, steady, deep pressure until he is able to feel the pulsation of both carotid arteries; and then the finger and thumb are slightly approximated so as to hold the trachea firmly and securely. The finger and thumb are not to be moved until the trachea is reached.

Fig. 1151.



Lines of incision in Bose's method of tracheotomy. (Mackenzie.)

As the surgeon cuts confidently down in the middle line by a series of careful incisions, the pressure upon the trachea causes that structure to advance and the wound to gape. When the trachea is reached, as indicated by the sensation imparted through the knife, or by examination from time to time with the forefinger of the right hand, it may be opened at once, or after having been secured with a sharp hook. In twenty-three cases in which this method has been adopted by Mr. Durlham, that surgeon has had no reason to regret the course pursued.

While it must be admitted that serious hemorrhage sometimes follows accidental or careless division of vessels unexpectedly found in the line of dissection, and occasionally with fatal results, it may be contended that the

well-known frequency and variety of abnormal distribution of bloodvessels should insure sufficient care on the part of the operator to keep him on the lookout for vessels in the way of his knife, until the trachea has been prepared for the incision into it. The finger, as well as the eye, must be brought into frequent requisition, and when the direct light is poor, a reflector should be used to illuminate the parts. If dangerous vessels cannot be avoided, they should be secured in advance.¹

In cases of excessive venous congestion, with threatening suffocation, in which time cannot be spared for securing vessels before or immediately after their division, it is sometimes necessary to complete the operation, despite the hemorrhage, so as to lay open the trachea, introducing the canula at once—when the bleeding may be expected to subside, as the re-establishment of respiration relieves the right chambers of the heart. Should normal respiration be delayed, artificial respiration must be instituted. The hemorrhage, however, does not invariably cease. The lesser of the two evils at hand, then, is to attempt completion of the operation, and give the patient a chance of resuscitation; the greater one is to delay, and let the patient suffocate beyond recovery.

CRICO-THYROID LARYNGOTOMY.—This operation presents little difficulty, the only tissues overlying the crico-thyroid membrane being skin and cervical fascia.

The patient being in the recumbent or semi-recumbent position, as circumstances may render desirable, and the position of the crico-thyroid membrane having been determined by palpation, the operator steadies the larynx between

¹ For descriptions of the anomalies of vessels alluded to, the reader is referred to Tiedemann's *Tabulæ Arteriarum*; Breschet's *Recherches Anatomiques, Physiologiques, et Pathologiques sur le Système Veineux*; Gross's *Foreign Bodies in the Air-passages*; and Pilcher's *Anatomy of the Anterior Median Region of the Neck* (*Annals of Anatomy and Surgery*, April, 1881).

the thumb and fingers of one hand, at the same time making the skin tense, and then incises the integument and fascia longitudinally for the distance of an inch or an inch and a half in the median line, so that the middle third of the cut shall uncover the ligament. The ligament is then freed from any superimposed tissue undivided in the primary incision. The communicating branch of the two crico-thyroid arteries is now pushed aside, or secured by torsion, or ligatures if need be, and the ligament is divided by a transverse or a longitudinal cut as the case may demand. Should the opening be insufficient, a cross-cut is made. Some surgeons prefer an incision along the cricoid cartilage, others one along the thyroid cartilage. The latter procedure should be preceded by ligation of the two crico-thyroid arteries. In incising the ligament the knife-blade should be made to penetrate into the larynx, for the ligamentous structure retracts immediately upon section, and otherwise a second cut may become necessary to divide the mucous membrane.

There is no risk of hemorrhage, save from the communicating branch of the two crico-thyroid arteries; but although usually slight, serious and even fatal bleeding from this source has been recorded.¹

THYROID-LARYNGOTOMY.—Division of the thyroid cartilage is an operation much less difficult than tracheotomy. Care is to be exercised lest the vocal bands be unnecessarily wounded.

The patient being in position, and the assistants placed as in tracheotomy, the surgeon makes a median, longitudinal incision through skin and fascia, extending from the hyoid bone to just below the cricoid cartilage. Upon separating these tissues, it is well to look whether any exceptional, anomalous vessel crosses the field of operation, and if such be the case to secure it by torsion or by ligature. A sharp-pointed knife is now thrust, blade upward, through the crico-thyroid ligament just beneath the median line of the thyroid cartilage, and the latter is then divided by an upward, sawing incision. If preferred, a probe-pointed knife may be substituted for this purpose. In either case, the middle line must be strictly maintained to avoid wounding the vocal bands. The knife must be a strong one. I have used a pair of probe-pointed, angular scissors very satisfactorily, in this stage of the operation. When the cartilage is so ossified as to resist section with the knife, a stout pair of angular scissors, or even a pair of bone-scissors, may be necessary to effect the division. Krishaber and others prefer to effect the division of the cartilage from the outside, whether by successive strokes with the knife, or by means of a small saw, in cases of ossification. The great advantage is said to be avoidance of the coughing which often complicates division after penetration of the larynx. When divided, the two halves of the cartilage are to be separated by strong blunt hooks, or other retractors, so as to admit of whatever operation in the interior of the larynx may be required. An ingenious device of Dr. Cutter's² consists in two pairs of steel forks with the tines turned into blunt hooks, one of which can be placed above a vocal band on each side and one below it.

Should it be necessary to perform what Heine³ has termed a resection of the larynx, the perichondrium is loosened with an elevator upon both sides of the two halves, as far as may be requisite, and the exposed cartilage is then removed with bone-pliers or saw, as may be required.

LARYNGO-TRACHEOTOMY is performed much more readily than tracheotomy, and is rarely attended with severe hemorrhage. It has long been thought

¹ Fergusson, *System of Practical Surgery*, p. 475. Philadelphia, 1853.

² *Am. Jour. Med. Sci.*, January, 1867.

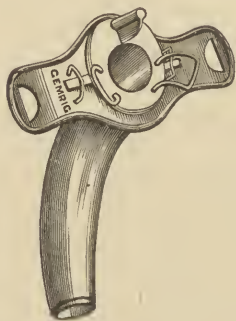
³ *Arch. f. klin. Chir.*, Bd. xix. S. 51

that section of the cricoid cartilage, the main feature of the operation, seriously impairs the stability of the larynx; but the freedom with which this cartilage has been divided of late years, without any published evidence of permanent injury sustained thereby, appears to demand a reconsideration of opinion upon this point. This operation is not to be selected when a tube is to be worn for any length of time, as necrosis may ensue from pressure. Two fatal cases of necrosis of this cartilage have come under Durham's observation.¹

The incision into the air-passage passes through the crico-thyroid membrane, the cricoid cartilage, the crico-tracheal membrane, and one or more rings of the trachea. The primary incision through the integuments is made a little higher up than for tracheotomy, commencing at the lower portion of the thyroid cartilage. The incision into the air-passage should be made from below upward to avoid wounding the isthmus of the thyroid gland. Even when the operation is an extension of an insufficient laryngotomy, it is better to cut from below upward into the first incision, than to extend the latter downward.

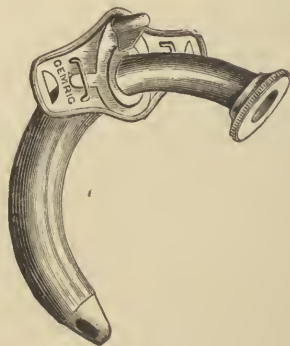
THE TRACHEAL CANULA.—In many cases, an artificial aperture into the air-passage must be kept open. The edges of the incision would soon unite were not some contrivance introduced to prevent this. A tube keeps the edges asunder, and permits ingress and egress of air for respiration. As mucus and other products might accumulate in sufficient quantity to clog the tube, it is customary to employ two tubes, as suggested by George Martin,² one fitting closely within the other, and projecting a little beyond it. (Fig. 1152.)

Fig. 1152.



Trousseau's double tracheotomy tube.

Fig. 1153.



Cohen's tracheotomy tube, with hollow conductor.

Should clogging occur, the inner tube is removed without disturbing the tissues at all, and is replaced when cleansed. The outer tube is made movable in a collar secured to the neck by tapes, and in this way it follows the movements of the neck with very little restriction. To facilitate the introduction

¹ Op. cit., vol. i. p. 773.

² Van Swieten's Commentaries, vol. xi. p. 528; Philosophical Transactions, 1737.

of the tube it is well to run a catheter into it, so that the blunt end shall serve as a pilot. The tubes used by myself, an improvement upon those of Krishaber,¹ are provided with a metallic catheter-conductor, the external extremity of which—the handle—curves downward, and gives exit in that direction to any blood or mucus which may be ejected by cough on its introduction. (Fig. 1153.) When the tube is in position, the pilot is withdrawn and replaced by the ordinary inner canula. A silver tube is preferable to one of hard rubber, because it encroaches less upon the space for air, and because by tarnishing it will indicate at what point, if at any, mortification has taken place. Tubes should not be used for long periods without occasional careful inspection, as they are liable to corrosion, and may then drop into the air-passage. The tube should be of equal calibre throughout. When smaller at the inner extremity, as are most of the tubes in use, the patient will get much less air than he is supposed to do, judging from the size of the external orifice.

The tube in general use has the form of the quadrant of a circle, which admits of the easy introduction of an inner tube; and the distal extremity is bevelled off so that it shall look downward instead of forward, and thus be much less likely to strike upon the anterior wall of the trachea. Much has been written about the shape of the tube. In the tracheotomies performed by myself, the quarter-circle tubes have been used almost invariably, and there has been no case of ulceration of the trachea to deplore. When evidences of abrasion have occurred, as noted by bloody stains upon the tube, the position of this can be altered by placing a compress underneath the neck-plate, thus relieving the tracheal wall from attrition. It is well to provide the patient with an additional tube, considerably shorter than the other, and to use the two on alternate days, so as to give the points of pressure alternate days of freedom. It has been a matter of observation that the track of the artificial passage through the soft tissues often becomes oblique in such a direction as to maintain the terminal extremity of a quarter-circle tube in the centre of the trachea. The calibre of the tube should be as great as is consistent with

Fig. 1154.

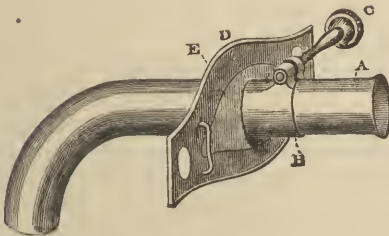
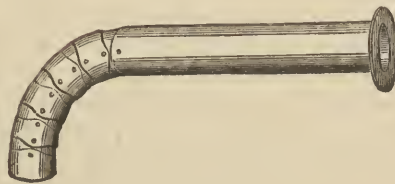


Fig. 1155



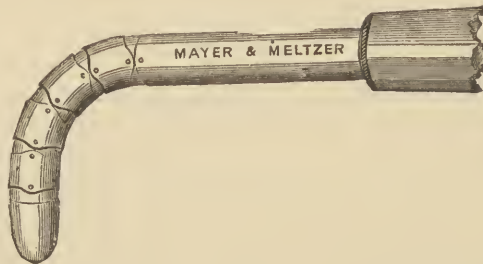
Durham's tracheotomy tube and inner cannula.

its easy introduction without touching the walls of the windpipe: six, eight, ten, and twelve millimetres in diameter, respectively, will, save in rare, exceptional instances, meet the requirements from infancy to maturity. Its length should be sufficient to insure it from being coughed out of the aperture

¹ *Annales des Maladies de l'Oreille, du Larynx, etc.*, Juillet, 1878, p. 142.

in the trachea. Erosions of the trachea are sometimes produced by ill-fitting tubes, and fungous granulations are not infrequent at the site of the erosions. To avoid these accidents, Mr. Durham has devised a tube so curved that the two extremities occupy rectangular planes,¹ the horizontal portion being movable in a collar attached to the sheath, so that it can be set at the most favorable point to permit the vertical portion to rest in the very centre of the trachea, and thus avoid attrition against its walls. (Figs. 1154, 1155.) As a rigid tube cannot be introduced within the outer one, the distal portion of the inner canula is articulated in lobster-tailed links. The piloting guide or trocar (Fig. 1156) has the same construction. These joints soon stiffen with mucus,

Fig. 1156.



Durham's piloting trocar.

which renders it difficult, and at times impossible, to remove the inner canula while the outer one remains *in situ*. Hence additional care is requisite to withdraw the inner canula at intervals sufficiently frequent to avoid this occurrence. Theoretically, this form of tube demands the maintenance of a horizontal track through the soft tissues into the trachea. Should this track become oblique by the weight of the tube, as certainly does happen in some instances, the very evil would be produced for the avoidance of which it was devised. Soft-rubber, single tubes have been recommended by Mr. Morratt Baker² for use after the first few days, as being more comfortable; they are open to the same objections as all other single tubes.

Whatever form of canula is used, it sometimes happens that difficulty is experienced in its introduction. When a conical conductor is not used, the edges of the incision may be held asunder by a tenaculum or blunt hook on each side, and the canula may be passed between them. The dilators already described are often used for this purpose. The introduction may be facilitated in many instances by holding the body of the canula transversely until the extremity has been passed into the trachea, and turning it downward as it is pushed further on. It is customary to warm the canula and to grease it before it is introduced into the artificial orifice. It thus enters more readily and excites less cough. Tapes are usually sewed to the slits or rings in the neck-piece, but buttons and button-holes render the tapes fully as secure as stitches, and permit their removal and renewal without disturbing the canula. One tape should be much longer than the other, so that the two can be tied at the side of the neck instead of at the nape, a plan much the more convenient.

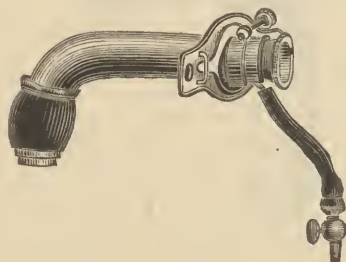
To occlude the space between the canula and the trachea, and thus prevent

¹ Practitioner, April, 1869, p. 212.

² Med.-Chir. Trans., vol. lx. p. 71.

the descent of blood in operations about the nose, mouth, pharynx, and larynx, Trendelenburg¹ has devised an elastic tampon-canula; the tracheal portion of the tube is encircled by an India-rubber jacket, into which air is forced from the exterior through a small tube along the side of the instrument. This has been improved by Semon,² who has adapted the device to the Durham canula, concealing the supply-tube in the interior of the instrument (Fig. 1157), and thus facilitating its introduction. Care is requisite in inflating the tampon, as sudden, excessive pressure may excite an asthmatic paroxysm.³ Fresh rubber may have to be stretched over the canula each time that it is used.

Fig. 1157.



Semon's tampon-canula. (Mackenzie.)

AFTER-TREATMENT OF TRACHEOTOMY, ETC.—More or less paroxysmal cough usually follows the introduction of the canula, but this generally subsides after a few minutes. Sometimes it is very slight indeed. The edges of the cutaneous wound above and below the canula may be united by sutures, or may be approximated by adhesive strips. A plan pursued by Dr. Packard, of Philadelphia, consists in fastening a longitudinal strip of perforated plaster on each side of the incision, and passing threads through a few of the projecting perforations, then lacing the threads together so that the edges of the wound are not disturbed at all. According to my own experience, the wounds do best without any dressing beneath the neck-piece of the canula. The air of the room should be kept moist, and a thin section of moistened sponge may be placed over the orifice of the tube, and be changed from time to time. The secretions become so dry, unless some such precaution is taken, that the tube is liable to become clogged with thick, desiccated crusts. It is to effect their ready riddance that a double canula is used, the inner one being removed and cleansed whenever respiration appears obstructed. When the disposition to the accumulation of these masses has ceased, a layer or two of moistened muslin-gauze may be substituted for the sponge. This is kept warm by the expiratory current of respiration, and thus the temperature of the inspiratory current is somewhat modified in cool weather. The patient should be continuously watched for twenty-four hours or more, so as to insure prompt attention to the tube. Bronchitis and broncho-pneumonia sometimes follow any operation upon the air-tube, and attention is requisite for several days to detect their initial symptoms. Should the patient desire to speak, it will be necessary for him or his attendant to occlude the external orifice of the tube with the finger, so that the expiratory current of air shall pass by the side of the tube, and thus set the vocal bands in vibration. As long as the air escapes by the tube there will be no voice, except in occasional instances of very capacious trachea.⁴ Patients who are compelled to wear the tube permanently are sometimes supplied with a special inner speaking-tube, provided with a valve at the external orifice which

¹ Berliner klin. Woch., No. 19, 1871.

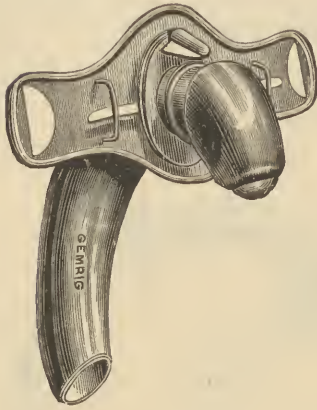
² Monatsschrift für Ohrenheilkunde u. s. w., No. 6, 1879.

³ Mackenzie, op. cit. (Am. ed.), vol. i. p. 378.

⁴ Cohen, Medical and Surgical Reporter, March 9, 1878.

admits the passage of the inspiratory, and prevents the passage of the expiratory current. The instrument of Luer (Fig. 1158), which is one of the

Fig. 1158.



Luer's pea-valve tracheotomy-tube.

best, has a curved, adjustable chamber, in which a light, hollow, silver ball falls forward by gravity during expiration, and is rolled backward against a pair of wires during inspiration. When skilfully made, the valve makes so little noise as rarely to attract attention. The use of the valve-tube often diminishes hypersecretion very materially, to the great comfort of the patient. At night, and at other times when not required for purposes of conversation, the valve should be removed, as it impedes, to some extent, the freedom of respiration. A patient upon whom I operated in 1876 has worn this appliance with great satisfaction for eight years.

When the time comes for permanent removal of the canula, the external orifice should be corked from time to time, to learn whether the patient can get enough air by the natural passages. A fenestrated canula

is not necessary for the purpose, as it is improper to use an instrument so large that an ample supply cannot pass by its sides. If a fenestrated canula be used, care must be taken that the opening is entirely beyond the track of the wound, as otherwise its edges will be apt to excite inflammation, which will be followed by the development of fungous granulations.

It must be borne in mind, that a number of accidental complications may occur during tracheotomy, or after it, some of which may cost the patient his life. Most of them are due to carelessness or negligence. Some take place despite every precaution. The posterior wall of the trachea may be penetrated, and a canula may even be passed right through it, into the œsophagus; the canula may be passed into the connective tissue in front of the trachea; there may be emphysema into the surrounding connective tissue, or perichondritis, chondritis, and necrosis; or there may be diffuse suppuration, fungous granulations, ulceration of the trachea penetrating even into the great arteries, stricture, or fistula. A knowledge that such things do occur should insure proper supervision of the wound, canula, and windpipe, until all danger of the sort has become a matter of the past. [See page 388.]

MORBID GROWTHS OF THE LARYNX.

Morbid growths rarely involve the skeleton of the larynx primarily. Sometimes they are developed on the exterior surface of the organ, but they occur much the most frequently in its interior. Occasionally they are both intralaryngeal and extra-laryngeal. The greater number by far are benign. Of the remainder, some are originally malign, while others become so secondarily.

BENIGN GROWTHS.—While seventy cases of laryngeal morbid growth would most likely include the entire ante-laryngoscopic record, they have been reported to the number of thousands during the last twenty-five years. They are less common in America than they appear to be in Europe. Their etiology is still obscure. Usually referred to "colds" as the starting point,

they appear due to local irritation during inflammations of the larynx, whether idiopathic, deuteropathic, or traumatic. Thus they follow simple laryngitis and, to a less extent, syphilitic and tuberculous laryngitis; the laryngitis of the exanthemata, measles especially; that of whooping-cough, croup, and diphtheria; that caused by inhalations of irritating matters; and that produced by local injuries. They are much more frequently single than multiple. The anterior portions of the larynx are the seat of morbid growths much more frequently than the posterior. Males suffer in far greater numbers than females. Some growths are congenital. Children acquire them at all ages; adults chiefly between the third and fifth decennia. My own experience includes their apparent development at the extremes of earliest infancy and the ninth decennium.

Fully two-thirds of all recorded cases of laryngeal neoplasm, are reported as papillomata. Of 100 cases of benign growth submitted to treatment by Mackenzie,¹ 67 were so considered; of 66 consecutive cases of growth of all kinds reported from my own practice,² 48 were known or inferred to be papillomata. Fauvel³ reported 206 out of a total of 300. Most other observers of large experience present analogous results. Elsberg,⁴ however, reports but 163 papillomata out of 310 morbid growths. The varieties of benign morbid growth, reported as having been detected in the larynx, include papilloma, fibroma, myxoma, adenoma, lymphoma, angeioma, cystoma, lipoma, and eechondroma. Some growths are composite. Fatty, colloid, and amyloid degenerations have been noted in some instances. Papillomata are usually sessile, and frequently multiple. Other neoplasms are usually single. The size of laryngeal neoplasms varies from that of small seeds to that of masses large enough to occlude the larynx and project above it. While they may occupy any portion of the larynx, they have been noted with greatest frequency upon the vocal bands. This may be partly due to the existence of the vascular papillæ discovered on the edges of these bands by Coyne,⁵ and partly a result of the vascularity maintained by their active movements in phonation.

Symptoms.—The general symptoms, much alike whatever the histological elements of the neoplasm, depend chiefly on its location, size, and character of attachment. Some growths do not give rise to any special symptoms. When located upon an important structure, when comparatively large, and when attached by a pedicle, they produce impairment of voice, impediment to respiration, difficulty of swallowing, cough, and pain. *Dysphonia* occurs only upon mechanical interference with due vibrations of the vocal bands. Thus, a fair voice may be maintained when a large growth is some distance from these structures, while hoarseness may be produced by a very small one upon them, beneath them, or between them, and intermittent hoarseness by a pedunculated growth, which interferes occasionally, or at frequent intervals, the voice failing and recovering itself several times, perhaps, during the enunciation of a single sentence. The alteration in voice may be limited to a certain portion of the register, when the growth occupies an acoustic node, and double voice, *diphthonia*, may result from symmetrical growths on the two bands, dividing the chink of the glottis into two portions. *Aphonia*, or absolute loss of voice, does not occur unless actual closure of the glottis has become impracticable. The voice during conversation is often unequal, or by turns hoarse, shrill, or muffled. It usually presents a peculiar dull quality,

¹ Essay on Growths in the Larynx. London, 1871.

² Diseases of the Throat, p. 415. New York, 1872.

³ *Traité Pratique des Maladies du Larynx*, p. 190. Paris, 1876.

⁴ *Archives of Laryngology*, p. 1. 1880.

⁵ *Recherches sur l'Anatomie de la Muqueuse Laryngée*, p. 21. Paris, 1874.

suggestive of a mechanical origin of the impairment, and unlike hoarseness and loss of voice from other causes. A characteristic "staccato" style of utterance, due to frequent inspiratory breaks, is often noticed with tumors that encroach much upon the glottis. *Dyspnœa* occurs only when the growth is large enough to obstruct respiration, or during intercurrent inflammatory swelling of parts adjacent. Indeed, such tolerance is acquired during the slow development of growths, that the lack of *dyspnœa*, sometimes compatible with very large neoplasms, is otherwise unaccountable. The *dyspnœa* varies with the size, location, and mobility of the growth. It may be extremely slight, except on exertion. It may be severe enough to threaten *apnœa*. It may exhibit any intensity between these extremes. Impaction of a neoplasm may suddenly produce suffocative *apnœa*, several fatal examples of which have been recorded by myself.¹ In some instances, usually indicative of a mobile growth, the *dyspnœa* is diminished by holding the head in a special manner. *Dysphagia* seldom occurs, unless the tumor occupies the epiglottis, an arytenoid or supra-arytenoid cartilage, or some portion of the pharyngeal surface of the larynx. Other things being equal, the *dysphagia* is generally proportionate to the size of the growth, although extreme difficulty of swallowing occasionally attends growths of insignificant volume. Regurgitation of food into the larynx sometimes takes place, and produces suffocative paroxysms. *Cough* is not a frequent symptom, unless the growth irritates or tickle the vocal bands, whether by its size, its location, or its mobility. Vascular growths bleed sometimes, and excite cough. The character of the cough varies with the nature of the growth and the intercurrent laryngitis: it may be dry and hacking, or moist; it may be sonorous, hoarse, muffled, or toneless, according as the vocal bands are inflamed or impeded in their movements. With growths of large size the cough is sometimes brassy, like the cough of croup and of acute laryngitis. There may be no expectoration, or there may be expectoration of mucus, or of mucus and blood. Sometimes portions of a growth are detached in coughing, and expectorated; occasionally a growth is expectorated entire. *Pain* is infrequent, and usually attributable to intercurrent causes. Considerable aching in the parts is not infrequent. Sometimes the sensation is that of a foreign body that the patient tries to cough out. Severe paroxysms of pain occur in occasional instances. Epileptic seizures may supervene² in susceptible subjects, as they do in other diseases of the larynx. Growths of unusual bulk occasionally produce some alteration in the contour of the larynx perceptible upon palpation.

Diagnosis.—This must be relegated to laryngoscopy. Palpation through the mouth may sometimes succeed in detecting an intra-laryngeal neoplasm, and more frequently an extra-laryngeal one; but the result is unsatisfactory even when the growth is large and quite high up. With children upon whom laryngoscopy may be impracticable, palpation may be the only available method of objective diagnosis; and it may be mentioned in passing that, under such circumstances, the opportunity should not be neglected, circumstances favoring it, to make an effort to dig the growth out with the finger, or to detach some portion of it. The mere detection of a growth laryngoscopically does not always complete the diagnosis as to its seat, location, size, and mobility. It is sometimes necessary to determine these points, important as guides to treatment, by palpation with a curved sound or flexible bougie manipulated under laryngoscopic inspection. The histological character of the growth cannot be accurately determined laryngoscopically; but certain general physical conditions about to be mentioned, are sufficiently characteristic to justify a probably correct inference. Portions of a growth may

¹ Op. cit. p. 540.

² Sommerbrodt, Berliner klinische Wochenschrift, 25 Sept. 1876.

be removed for closer examination, but even then, there is sometimes uncertainty as to the question of composite structure.

Papillomata (Figs. 1159 and 1160) are often multiple, usually sessile, more or less dendritic, and sometimes racemose. Their color varies from the merest tinge of red to an intense red. Some are quite white. Their size

Fig. 1159.



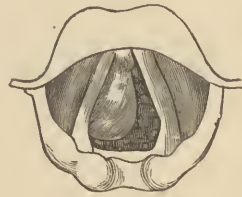
Multiple papillomata of the larynx.

Fig. 1160.



Larynx after their removal.

Fig. 1161.



Laryngeal fibroma.

varies from that of small seeds to that of mulberries, or a series of mulberries. Sometimes they seem to fill the upper cavity of the larynx. They usually occupy the anterior portion of the larynx, and their most frequent seat seems to be a vocal band.

Fibromata (Fig. 1161) are usually single,¹ smooth, and pendunculated. The pedicle is sometimes attached vertically, sometimes transversely. Most fibromata are red. Some are white or gray. Some of them are vascular on the surface. They are more uniform in size than the papillomata, and slower in development. Their size varies from that of a small pea to that of quite a large nut. They are most frequent on the vocal band.

Myxomata, which are quite rare, are usually single,² smooth, or slightly irregular in form, and pedunculated. They are pink or red, and their size varies from that of small seeds to that of large beans. They are most frequent at the commissure of the vocal bands.

Angeliomata (Fig. 1162), of which I have seen but four examples in my own practice, are usually single, reddish or bluish-black, of size varying from that of small peas to that of mulberries, and most frequent upon the vocal bands. Wagner³ has reported one in a ventricle, and Mackenzie one in the pyriform sinus.⁴

Lipomata, of which I have not seen any example, may be so large as nearly to fill the larynx.⁵ In V. von Bruns's case, the growth was sessile, lobulated, elastic, red, and located on the left arytenoid cartilage.

Cystomata are usually sessile, globular, translucent, and white or red. They occupy a vocal band occasionally (Fig. 1163), but a ventricle or the epiglottis more frequently. In a case observed in my own clinic, a cyst was seen to occupy both a ventricle and the glosso-epiglottic sinus.

Ecchondromata, unlike other benign growths, seem to be developed chiefly in the posterior portions of the larynx. Thus Stoerk⁶ reports a case of large ecchondroma developed from the base of the left arytenoid cartilage;

¹ A case of multiple fibromata (six) has been reported by myself. Medical Record, p. 265. 1869.

² A case of multiple myxomata (three) has been reported by myself. Transactions of the Pathological Society of Philadelphia, p. 151. 1873.

³ Archives of Laryngology, p. 332. 1880.

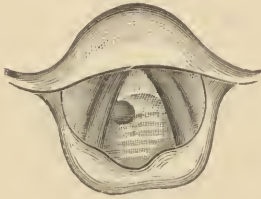
⁴ Essay on Growths in the Larynx, Plate II. Fig. 12.

⁵ V. von Bruns, Dreiundzwanzig neue Beobachtungen von Polypen des Kehlkopfes, S. 84. Tübingen, 1868.

⁶ Op. cit., S. 417.

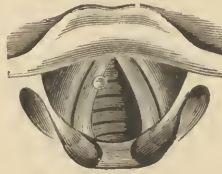
Ehrendorfer,¹ one growing inwards from the back of the cricoid cartilage; Musser,² one the size of a walnut projecting into the interior from the laryngeal face of the posterior portion of the cricoid cartilage; and Asch,³ one springing forwards and inwards from the inner surface of the thyroid carti-

Fig. 1162.



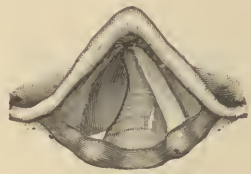
Angioma on vocal band.

Fig. 1163.



Cystoma.

Fig. 1164.



Prolapsus of laryngeal sac.

lage, apparently at the base of the superior cornu of the right side. The presence of a firm neoplasm, then, in the posterior portion of the larynx, should suggest a possible ecchondroma. When denuded of its mucous membrane, the glistening of the tumor through the rent adds additional probability to the diagnosis. Hardness on palpation is insufficient for differentiation from fibroma.

The other benign growths do not seem to present characteristics sufficient for diagnosis by inspection.

Care is requisite to distinguish morbid growths from prolapsus of the laryngeal sac (Fig. 1164), of which a few examples are on record;⁴ from gummata; from exuberant granulations about ulcerated surfaces; and from mere wrinkling of the mucous membrane in movement.

Prolapsus of a laryngeal sac can sometimes be differentiated by replacing the mucous membrane by means of a probe. By mere inspection, the differentiation would depend on the absence of all indication of a ventricle along the line of the tumor.

Prognosis.—The prognosis is generally favorable, provided that the morbid growth is detected, and that proper surgical treatment is instituted. Should proper treatment be declined, neglected, or delayed, death by sudden suffocation may ensue, in cases in which the tumor actually occludes the chink of the glottis, or is liable to become impacted in it. This danger of suffocation lends clinical malignancy to formations histologically benign. Restoration of normal voice, or of practically normal voice, usually follows the removal of neoplasms from the vocal bands, unless these structures suffer injury. Permanent impairment of the voice is a frequent sequel of the division of the thyroid cartilage, sometimes practised to get direct access to intra-laryngeal growths; not as a result of the removal of the growth, but in consequence of cicatricial adhesion at the commissure of the vocal bands. Recurrence of morbid growth should be less frequent after removal by direct access, yet statistics seem to show that it is less liable to follow removal through the mouth.⁵ Recurrences are almost limited to sessile papillomata, and are often outgrowths

¹ Wiener med. Woch., 2 Juli, 1881; London Med. Record, Feb. 15, 1882, p. 65.

² Phila. Med. Times, May 6, 1882.

³ New York Med. Journal, Aug. 30, 1884, p. 235.

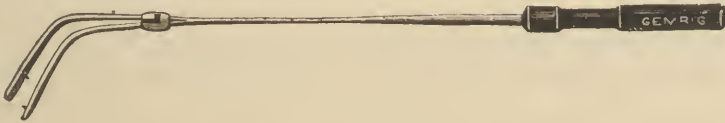
⁴ Moxon, Trans. Path. Soc. Lond., p. 65. 1868; Mackenzie, op. cit., p. 34; Lefferts, Medical Record, June 3, 1876; Elsberg, Archives of Laryngology, January, 1882, p. 67; Cohen, ibid., p. 66; Arnold, Medical News, May 5, 1883, p. 512.

⁵ Bruns, Die Laryngotomie zur Entfernung intralaryngealen Neubildungen, S. 148. Berlin, 1878. For a contrary opinion, see Browne, The Throat and its Diseases, p. 251. London, 1878.

from remnants of ill-extirpated growths, inefficiently cauterized. Some so-called recurrences are developments in new sites, and in no way associated with the original neoplasm. Papillomas are sometimes tortured into malignancy by irritation attributable to numerous unsuccessful attempts at evulsion, and occasionally by irritation from harassing cough and local friction. Fibromas and adenomas occasionally undergo malignant transformation. Growths unoperated upon, and growths subjected to inefficient, meddling interference, sometimes undergo suppurative inflammation, with development of an abscess which usually points externally, whether through the cricothyroid membrane, or directly through the intermediate thyroid cartilage. The spontaneous or operative discharge of the contents of the abscess is sometimes followed by fistula. Some growths, probably merely local thickenings of tissue, occasionally undergo spontaneous absorption; and veritable neoplasms sometimes undergo spontaneous detachment.

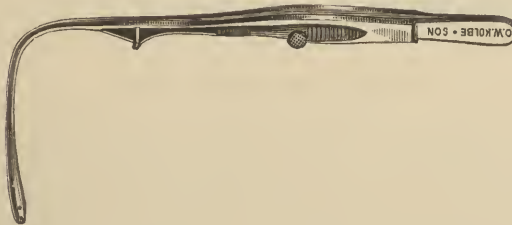
Treatment of Benign Laryngeal Growths.—Small growths, offering no impediment to respiration, present no indication for surgical interference, save when they impair the voice of an individual dependent upon its use for a livelihood. In other instances, slight hoarseness can readily be tolerated; and the indication for intervention remains optional unless the growth undergoes enlargement, when prompt measures for its removal become advisable. Small growths often remain stationary for long series of years. Medical treatment may be dismissed as useless, except in syphilitic subjects in whom condylomata or gummata may be mistaken for neoplasms. Even in the case of tuberculous granulomata, surgical treatment is often indispensable.

Fig. 1165.



Flexible sponge-holder with bayonet-catch.

Fig. 1166.



Cohen's rigid sponge-holder with lateral slide-catch.

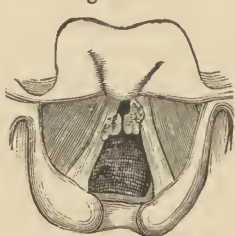
Two methods of surgical treatment are in vogue: one by way of the natural passage, principally or practically under laryngoscopic guidance; the other by direct attack, after external incision into the larynx.

Intra-laryngeal procedures comprise chemical or thermic cauterization, incision, abscission, crushing compression, and evulsion.

Cauterization.—Small, soft papillomata, favorably located, may sometimes be destroyed by repeated applications of concentrated solutions of zinc-chloride, silver-nitrate, or chromic acid, or by applications of nitric acid, acid solution of mercuric nitrate, Vienna or London pastes, or the electric cautery. To avoid unpleasant accidents, preliminary, tentative efforts are necessary, in order that the requisite steadiness of the patient, and that accurate manipulation by the surgeon, may be assured. Concentrated caustic solutions are best applied by means of small fragments of sponge, firmly secured in reliable forceps. (Figs. 1165, 1166.)

Solid caustics—silver nitrate and chromic acid—are best applied molten upon the roughened extremity of an aluminum probe. Concealed-caustic holders are clumsy to manage, and misleading as to accuracy in manipulation. With tact and practice, the uncovered caustic can be applied thoroughly, and with equal safety. Repeated applications, at intervals of a day or longer, are usually requisite. The best chemical caustic, in most instances, is chromic acid. Its admirable effect is delineated in Figs. 1167 and 1168.

Fig. 1167



Growths on both vocal bands.

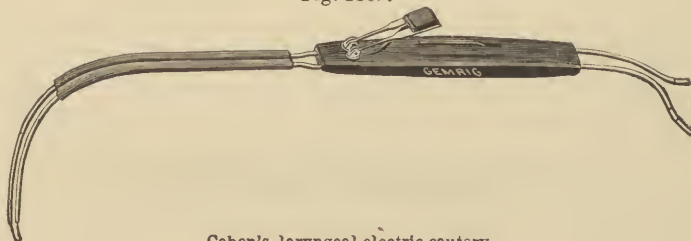
Fig. 1168.



Appearance of bands after destruction of growth by chromic acid.

Treatment by silver-nitrate is much more protracted. The electric cautery (Figs. 1169 and 1170) is preferred by many laryngologists, but is not in

Fig. 1169.



Cohen's laryngeal electric cautery.

much favor with surgeons. Electric cauterization, while neither as painless nor as bloodless a procedure as has been asserted, is more liable than other methods of cauterization to excite acute traumatic laryngitis, and to be followed by secondary hemorrhage on detachment of the eschar. Whether a broad cautery or a pointed one is to be used, will depend upon individual indications. The shape of the laryngeal curve can be readily altered by bending the conducting wires. Löwenberg, of Paris, has simplified this method of treatment by wrapping the insulating threads in such a manner as to leave exposed merely the segment of terminal to be pressed against the growth. In this manner the sound tissues are better protected. As a rule, collateral inflammation is greater after electric than after chemical cauterization. Neither method is desirable if the growth can be removed with

forceps. Either may be employed to destroy remnants of growths removed by other procedures. Either is applicable in case of small growths, too small to be caught in the grasp of forceps. The caustic must be retained in contact with the growth for at least two seconds. Momentary contact merely scorches the mucous membrane, and is liable to excite additional hyperplasia. The cauterizations are to be repeated at intervals of two days or more, according to the results. Immediate inflammatory effects may be moderated by sucking ice for a time. Suffocative spasm follows the first manipulations, but becomes more and more controllable thereafter. Voluntary, prolonged expiration is the best controller of such spasm, which usually relaxes with the deep inspiration succeeding. Intense spasm usually yields readily to the inhalation of amyl-nitrite. The posterior portion of the larynx is far more susceptible than the anterior. Fortunately, the growths under consideration usually occupy the anterior portion. Fortunately, too, the growth is rarely sensitive, however sensitive the surrounding structures. The tissues must be gradually injured to bear caustic applications. Life has been sacrificed by neglect of this precaution. The procedure may be regarded as safe, however, in discreet hands. Various methods have been recommended for producing local anæsthesia to avoid spasm, systemic anæsthesia being unsuitable to intra-laryngeal surgery. None are wholly satisfactory, and some are actually dangerous. It is far preferable to accustom the parts to the contact of probes and forceps, and thus induce a tolerance to more active measures.

Incision is performed with knife blades, attached to properly curved rods. To meet the various indications, the blades must present their cutting edges in the proper directions (Fig. 1171). In skilled hands, naked instruments are better than concealed ones; but the method of incision is so little in use and so generally superseded, that more than its mere mention is hardly necessary.

Abscission is performed with knives such as those mentioned, with scissors, with cutting forceps, and with guillotines similar to those used for abscission

Fig. 1170.



Cautery terminals. (Bruns.)

Fig. 1171.

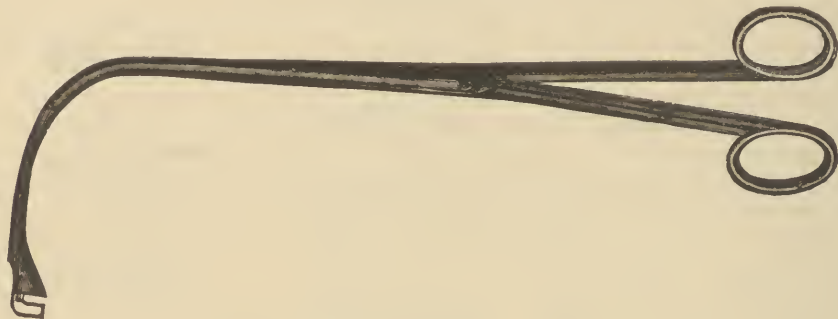


Laryngeal knives. (Tobold.)

of tonsils. Knives are open to the objection of inflicting injury on the epiglottis, the tongue, or some other structure, in their withdrawal. Scissors (Fig. 1172) are rarely used, but are more effective than knives. Guillotines are much the safest instruments, especially the guarded guillotine of Stoerk

(Fig. 1173), perhaps the best of its class, which protects the adjacent tissues from the knife; but they can be used only with growths small enough to be encircled by the annular blade, and their usefulness is therefore much restricted. Personally, I am not partial to any of these cutting operations; and have virtually discarded them. It is rarely that a satisfactory incision

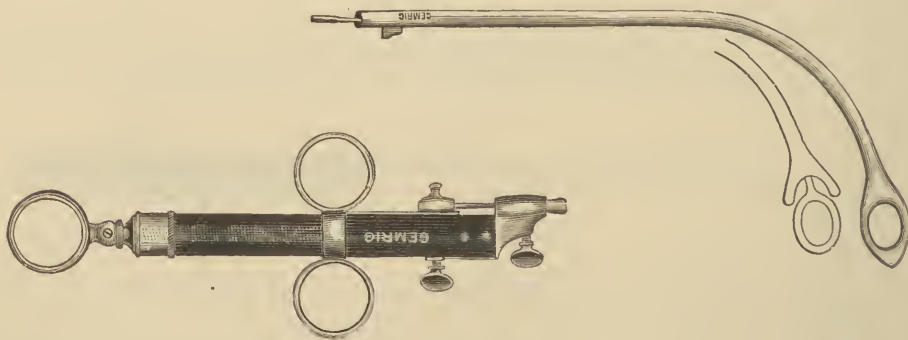
Fig. 1172.



Perpendicularly cutting scissors. (Tobold.)

can be made in a single movement. Furthermore, the hemorrhage produced, slight though it may be, produces cough, and usually obscures the field to an extent that prevents further manipulation at the time. The opinion that injury may result from forcible inspiration of the portions of growth detached, is to some extent justifiable, although the fragments are usually ejected by coughing. Excision of fragments, by the cutting blades of forceps of the same shapes as are used in evulsion, is requisite in cases of large growth, and is usually a satisfactory procedure. The portions excised are removed in the grasp of the instrument. As the capacity of this is limited, a number of excisions are necessary, usually requiring several sittings, should the field

Fig. 1173.



Stoerk's universal handle, with two forms of guillotine.

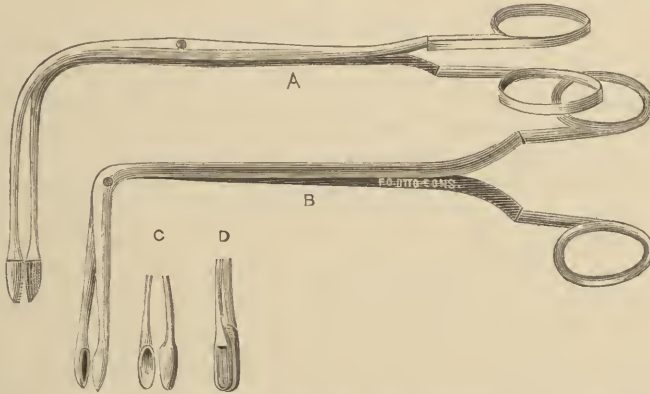
become at all obscured by blood. The hemorrhage in all these procedures is rarely of much significance. Dr. Edward Lori removes laryngeal growths with catheter-polypotomes—metallic catheters with eye-holes at various positions around their distal extremities, the edges being sharpened so as to cut through any soft morbid growths which may be caught in them. Ross-

bach¹ introduces a knife through the lamina intermedia of the thyroid cartilage, and manipulates it under guidance of the laryngoscopic mirror.

Crushing compression of a growth is practised in cases which resist evulsion with forceps, or in which it becomes apparent that too much force would be requisite to tear the growth away. The object is to produce mortification, and thus favor subsequent detachment by suppurative processes. Crushing is practised with strong forceps similar to those used for evulsion.

Evulsion, or tearing the growth away bodily, is the method most frequently applicable. Pedunculated growths are readily torn away; and sessile growths likewise can often be torn away in mass. Soft growths of large size are usually torn away in fragments, two or three being removed at a sitting. Many sittings are often requisite to free the larynx from extensive growths. These operations are performed with forceps—simple, complex, canulated, rigid, and elastic. Many operators have devised forceps to meet their special preferences; but, as with most surgical implements, the simplest are the best. The forceps devised by Mackenzie, of London (Fig. 1174), certainly fill the greatest number of indications, and are, perhaps, the most useful of the entire

Fig. 1174.



Mackenzie's laryngeal forceps. (Mackenzie.) A. Lateral toothed forceps. B. Antero-posterior cutting forceps. C. Spoon-blade. D. Punch-blade.

class. Too much force should not be exercised in evulsion; a growth may be so firmly attached that the whole larynx is lifted with it. Under such circumstances cutting forceps should be substituted. Wire-snare, and even *éraseurs*, have been used to remove growths by cutting and by evulsion, but their manipulation is so difficult and uncertain that they are of questionable value. Evulsion with the finger or finger-nail is occasionally practicable with soft growths high up, especially in children. Evulsion is also practicable by passing a sponge into the larynx and twirling it around and around, rather roughly. Although chiefly applicable to soft growths, Voltolini, of Breslau, who is the originator and chief advocate of this procedure, has reported successes obtained by it with fibromata and myxomata, pedunculated and sessile.² In the treatment of growths of hard consistence, the manipulations are repeated at intervals of from four to eight days, until the growth becomes mortified and drops off. Voltolini has also recently devised a fork for the transfixion and excision of laryngeal growths.

Although laryngoscopy has given the great impetus to removals of growths

¹ Berlin, klin. Woch., No. 5, 1880.

² Monatsschrift für Ohrenheilkunde, 3 November, 1878.

by intra-laryngeal procedure, operations were successfully performed in this way by Koderick, of Brussels, in 1750, and by Horace Green, of New York, in 1845. Dr. Green,¹ in fact, performed Voltolini's operation, but attributed too much of the good result to the solution of silver-nitrate in which he was accustomed to dip the sponge.

Treatment by Direct Access.—While the great majority of intra-laryngeal neoplasms are so accessible to treatment by way of the mouth as to render an external operation unjustifiable, the location and magnitude of a growth, the timidity and intractability of the patient, or the limited resources of the surgeon, may render an intra-laryngeal procedure hazardous and impracticable. Under such circumstances, safety may often be secured by performing a prophylactic tracheotomy first, and trying intra-laryngeal measures afterwards. Urgency for interference, and assurance that the tissues shall be thoroughly cleared of morbid growth, sometimes create an imperative demand for external access to the neoplasms. Several operations are practised for this purpose, the choice depending on individual requirements. These operations include section of the middle crico-thyroid ligament; section of the thyroid cartilage in the middle line; section of both of these structures; section of the entire larynx; section of the trachea; and section of the thyro-hyoid membrane. Section of the cricoid cartilage should be avoided if practicable, on account of its liability, slight as this may be, to be followed by necrosis. Section of the thyroid cartilage is to be avoided if other means will furnish ample access to the neoplasm, because the cicatricial agglutination of the anterior portions of the vocal bands cannot be effectively prevented. The resulting shortening of their vibrating portions impairs the voice, the shrill accentuation of which subjects a sensitive female to continuous mortification.

Section of the middle crico-thyroid ligament, *meso-chondric laryngotomy*, the easiest operation of the series, involves the least risk, leaves an insignificant cicatrix, and does not injure the voice. It offers sufficient access to small growths beneath the vocal bands, or upon their edges, inaccessible to intra-laryngeal procedure; and is indicated in individuals whose means of livelihood depend upon the integrity of the voice, or in others who are rendered irritable by the presence of growths which impair the voice, even though the function of respiration remain undisturbed. The growth once exposed, may be removed with delicate scissors, forceps, or electric cautery. In the adult, the external wound is usually amply capacious for the temporary retention of a canula when this is advisable.

Section of the thyroid cartilage, *thyrotomy*, *thyroidotomy*, *thyroid laryngotomy*, is indicated to remove extensive intra-laryngeal neoplasms which are inaccessible to thorough laryngoscopic operation, or to the simpler external procedures. Its liability to impair the voice irretrievably, renders it questionable, at times, whether the more conservative operation of sub-hyoid pharyngotomy would not be the preferable procedure, especially in the case of children, and when the growth is located very high up. Should section of the thyroid cartilage expose the interior sufficiently, the crico-thyroid ligament should be spared. Should section of both these structures prove insufficient, it will become necessary to divide the cricoid cartilage in addition. If sufficient access can be secured without dividing the thyroid cartilage quite up to the thyro-hyoid membrane, a little strip may be spared, in order to secure such cicatrization as may better ensure retention of the vocal bands in their original planes, and thus cause less impairment of the voice. The operation, whatever its extent, is usually practised after a preliminary tracheotomy, whether at the time or a

¹ On the Surgical Treatment of Polypi of the Larynx and Œdema of the Glottis, p. 71. New York, 1852.

few days in advance. It can often be undertaken with perfect safety, however, without such precaution.

Section of the trachea, *tracheotomy*, is sometimes practised for the purpose of operating upon subglottic growths, directly through the tracheal wound. In a few tracheotomies by myself, preliminary to intra-laryngeal operations, I have failed to make immediate use of the incisions in removing the growths, because the entrance of blood into the trachea, and the cough excited, have so obscured the field and disturbed the illumination that the practice has not appeared safe; but I have made successful use of the wound a few days after the tracheotomy.

Lateral Laryngotomy.—Luschka has described¹ a lateral thyroïdal laryngotomy suitable for gaining access to morbid growths in the ventricle without doing injury to the vocal bands. A longitudinal incision is made down to the thyroid cartilage, starting at the junction between the first and second fourths of the horizontal interval between the superior incisure of the thyroid cartilage and its posterior border. The thyroid cartilage is then split from top to bottom, and its edges held asunder with blunt hooks, when the upper end of the laryngeal sac comes in view, so that no difficulty is presented in dividing its lateral wall as far as the level of the upper surface of the vocal band. I am unaware that this operation has ever been performed on the living subject.

Section of the thyro-hyoid membrane, *sub-hyoid pharyngotomy*, sometimes called *supra-thyroid laryngotomy*, rarely affords sufficient access for the efficient use of instruments, even in the adult, and its usefulness is therefore restricted. The operation is comparatively easy, and does not subject any important structure to injury, either at the time or subsequently. It is sometimes practised to excise the epiglottis, or to remove a growth from the upper portion of the larynx, or to extract impacted foreign bodies, otherwise inaccessible. It is an operation imitating the wound sometimes made by the suicide. First practised by Bichat in physiological investigations upon animals,² its performance on the human subject for surgical purposes was suggested by Malgaigne³ and by Vidal (de Cassis), and it was first executed by Dr. Prat⁴ for removal of a tumor of the epiglottis. Of six cases of this operation for removal of tumors, collated by me in 1878,⁵ three terminated fatally within a few days after the operation. The operation itself, however, is not a serious one under ordinary circumstances, as no important structures, vessels, or nerves, are subjected to injury; but its limited availability rarely justifies its employment for the removal of morbid growths, especially because, as intimated by Mackenzie, cases favorable for its performance are just those most easily treated through the mouth.

To perform this operation, a transverse incision is made parallel with the lower border of the hyoid bone, dividing skin, fascia, sterno-hyoid muscles, hyo-thyroid membrane, and pharynx—button-holing the tissues between the tongue and the epiglottis. The epiglottis is then drawn out through the wound, and the pharyngeal outlet of the larynx is exposed. The advantage over splitting the larynx is the avoidance of injury to the cartilage and to the vocal bands.

The removal of tumors exposed by direct access is effected by holding the edges of the severed tissues apart, illuminating the interior by direct or reflex light, as may be most effective, and then removing the growth with knife, scissors, wire or chain loop, or electric cautery, as may seem most feasible and

¹ Der Kehlkopf des Menschen, S. 18. Tübingen, 1871.

² Traité d'Anatomie Descriptive, t. ii. p. 402. Paris, 1819.

³ Manuel de Médecine Opératoire. Paris, 1835.

⁴ Gaz. des Hôp., No. 103, p. 849. 1859.

⁵ Op. cit., p. 575.

judicious. The surfaces from which the growths have been removed should then be thoroughly cauterized with the thermic cauter, silver-nitrate, or zinc-chloride, to destroy remnants and prevent repullulation. These manipulations are by no means easy. The spasmodic heaving of the parts when touched with an instrument, the cough, and the hemorrhage, often interfere with a continuous operation and render its steps uneven, uncertain, and tedious. Should preliminary tracheotomy have been performed, the canula should be retained in use until it has become evident that intra-laryngeal cicatrization has been safely accomplished.

It is hardly necessary to enter into any argument as to the preference to be given to intra-laryngeal procedures over the operations just described. If a tumor can be removed by way of the mouth, with safety to the patient, he should not be unnecessarily subjected to an external operation. If the matter be doubtful, a preliminary tracheotomy should insure him from suffocation under the manipulation. If, however, the growth be below the vocal bands, and inaccessible through the mouth, or if it be so extensive as to preclude thorough eradication by way of the mouth, the external operation should be resorted to without wasting valuable time in tearing little bits away to no purpose.

MALIGN TUMORS.—These growths, malignant histologically and clinically, comprise the groups Sarcoma and Carcinoma.

I. Sarcoma.—The varieties of sarcoma reported as having been seen in the larynx, comprise the spindle-celled, round-celled, giant-celled, and mixed-celled, and the composite neoplasms, fibro-sarcoma, lympho-sarcoma and myxo-sarcoma. Sarcoma of the larynx is usually single, and rarely exceeds the size of a small walnut or of a pigeon's egg. Some examples have been reported the size of small beans. The disease is rare, only twenty-three instances having been collected as the basis of an admirable study by Mr. Butlin,¹ to which, and

Fig. 1175.



Fig. 1176



Small-celled sarcoma on left ventricular band. (Jurist.) Fig. 1175, Before section of larynx. Fig. 1176, Larynx opened posteriorly.

for which, I beg here to acknowledge my own indebtedness. Most cases are primary. A few have been reported as secondary.² Most sarcomas originate

¹ On Malignant Disease (Sarcoma and Carcinoma) of the Larynx. London, 1883.

² Eppinger (Klebs, Handbuch der pathologischen Anatomie, Bd. ii. Abth. 1, S. 209. Berlin, 1880).

in the interior of the larynx, and principally upon the vocal band or on the ventricular band (Figs. 1175, 1176), as irregular, spheroidal masses, smooth, nodulated, mammillated, or even somewhat dendritic. Thence the growth may extend outward by infiltration, penetrating not only the membranous, but even the cartilaginous framework of the larynx.

The epiglottis seems to be the most common seat of sarcoma of the larynx originating outside of the actual aërial tract. The disease seems to extend only by continuity of tissue, and not by lymphatic involvement or by secondary formation. It is most frequently seen in patients between the ages of twenty-five and fifty, and far the more frequently in males. Its progress is not apt to be quick, for the first year or two; but it sometimes becomes exceedingly rapid.

Symptoms.—The subjective symptoms are those of neoplasms generally: dysphonia, dyspnoea, sensation of foreign body, cough, and dysphagia, all varying in intensity with the location, size, and mobility of the tumor. Pain is quite infrequent. The symptoms of a tumor large enough to produce death by suffocation may even be too slight to prompt the patient to seek medical advice. Thus in the unpublished case from which the specimen shown in Figs. 1175, 1176, was taken, and for which I am indebted to Dr. Louis Jurist, one of the Chiefs of Clinic in the throat-department of the Jefferson Medical College Hospital, the patient, a gardener, sixty-five years of age, had not applied to a physician until forty-eight hours before his death, which took place within less than twenty-four hours after he had declined to undergo tracheotomy, proposed by Dr. Jurist as the immediate outcome of a laryngoscopic examination.

Diagnosis.—Sarcoma usually appears as a well circumscribed, hard, sessile tumor, smooth or lobulated, sometimes somewhat dendritic at the surface, the mucous membrane being sometimes paler than normal, sometimes deeply congested, sometimes vascular. Superficial ulceration to a limited extent occurs in some instances. These characters are easily recognizable in the laryngoscopic image. Dendritic sarcomata may readily be mistaken for papillomata; but a dendritic formation in the posterior portion of the larynx would be probably a sarcoma, as papillomata are almost always located anteriorly.

Sarcoma is distinguishable from carcinoma by non-involvement of the lymphatic glands—a fact of the greatest clinical value, and accounted for by Mr. Butlin¹ in the suggestion that the lymphatic vessels become mechanically obliterated in the growth of the tumor. The importance of discrimination from benign growths on the one hand, and from carcinoma on the other, renders it essential to remove, with cutting forceps, a small portion of the growth for its submission to careful microscopic examination.

Prognosis.—Unsubmitted to operation, sarcoma is fatal; death occurs by asthenia, or by suffocative apnoea from occlusion of the air-tract. In cases of extensive disease, recurrence will take place unless the extirpation of the growth has been thorough. If the diseased tissues be entirely removed, the prognosis as to life is rendered favorable. Good results have followed procedures involving partial or complete laryngectomy. (See tables in section on Laryngectomy.)

Of five patients upon whom total laryngectomy has been performed² for sarcoma, one, operated upon by Lange, lived nearly seven months; one, by Czerny, nearly fifteen months; and one, by Foulis, nearly seventeen and a half months; one, operated on by Caselli, was alive nearly two years (August, 1881) after the

¹ Op. cit., p. 14.

² Transactions of the College of Physicians. Philadelphia, 1883.

operation; and one, operated on by Bottini, February 6, 1875, is alive nearly ten years after the operation.¹ Correspondence instituted for the purpose has failed to elicit the present state of Caselli's patient.² Taking for granted that death was imminent in these five cases, we find considerable prolongation of life in all of them, and a remarkable prolongation in two. These statistics, therefore, indicate that the operation of excision of the larynx deserves the serious consideration of the surgeon in otherwise hopeless cases of sarcoma.

Treatment.—Radical treatment must be surgical. When the growth is small and readily accessible in all its parts, operative procedures may be limited to the region diseased. Cures by intra-laryngeal operation have been reported by Tuerek, Gottstein, Navratil, and Mackenzie,³ but the infiltrating character of the growth, so strongly insisted on by Mr. Butlin, renders it questionable whether such measures should be relied upon, and renders it imperative that the patients should be subsequently examined from time to time, to ascertain whether apparent cures have been permanent. When the growth occupies a peculiarly favorable position upon the posterior wall of the larynx (Fig. 1177), it is accessible through the mouth; and when

Fig. 1177.



Sarcoma growing from the posterior surface of the cricoid cartilage. (Mackenzie.) A, *in situ*; B, after removal.

it occupies the epiglottis, that structure may be removed—sometimes through the mouth, and sometimes by the operation described as sub-hyoidean pharyngotomy. When the interior of the larynx is the seat of the disease, thyroid laryngotomy, or section of the thyroid cartilage, or perhaps section of the entire larynx, will be required to afford proper access for efficient removal. When such exposure of the parts is insufficient for thorough eradication of the diseased tissues, the question of partial or complete extirpation of the larynx may be entertained; for the results of these operations for sarcoma, as exhibited in the tables hereafter given, are far more satisfactory than when they are undertaken for carcinoma.

II. *Carcinoma.*—Carcinoma is much more frequent than sarcoma; more frequent, perhaps, than is generally recognized. Most frequently a primary disease,⁴ and limited to the larynx, it occurs also in extension from disease in contiguous organs—the tongue, œsophagus, pharynx, or palate, in one direction, and the thyroid gland⁵ in the other. Squamous-celled carcinoma occa-

¹ Private letter from Prof. F. Massei, dated October 7, 1884.

² It must be noted, in connection with this case, that Margary (*Arch. Ital. di Laringologia*, p. 132. 1882), states that the growth was a granuloma, and not malignant. A private communication to myself, from another Italian physician of authority, reiterates this opinion.

³ *Op. cit.*, p. 351, vol. i.

⁴ Ziemssen, *Handbuch der speciellen Pathologie*, u. s. w. Bd. iv. H. 1. 1875.

⁵ Eppinger (*Klebs, op. cit.*, Bd. ii. Abth. 1, S. 213).

sionally excites consecutive disease in other organs.¹ The growth may be first developed in the interior of the larynx (*intrinsic carcinoma*, Krishaber), or in the epiglottis and the external wall (*extrinsic carcinoma*, Krishaber). It occurs most frequently as epithelioma (*squamous-celled carcinoma*, Butlin), sometimes as large spheroidal-celled,² occasionally as small spheroidal-celled, and very rarely as cylindrical-celled carcinoma. Intrinsic carcinoma, at least at first, is usually unilateral—the left side being involved the more frequently—and begins in the superior portion of the larynx, especially at the vocal band. Afterwards, both sides become involved. All the infra-glottic tumors cited by Butlin,³ five in number, were situated immediately beneath the vocal band. The disease seldom extends to the œsophagus, or penetrates externally. Extrinsic carcinoma affects the epiglottis most frequently, and occasionally exclusively. It has been known to begin in the cutaneous cicatrix following thyroïdal laryngotomy.⁴

Carcinoma rarely remains circumscribed, for its tendency is to infiltrate and destroy all the tissues of the larynx, and the tissues immediately contiguous, extending at times into the pharynx or out upon the neck. The large spheroidal-celled variety exhibits greater tendency to ulceration extending to adjoining tissues, the squamous-celled variety greater tendency to ulcerative destruction of its own mass; hence hemorrhage often results, always exhausting, occasionally fatal. Perichondritis, abscess, necrosis, and fistula occur in some cases of long standing. Lymphatic involvement is not constant with any variety, and is much less frequent in intrinsic than in extrinsic carcinoma.

Carcinoma is far the more frequent in adults, and in greatest frequency between the ages of fifty and seventy. Yet it has been detected during the very first year of life,⁵ and at three years,⁶ and has occurred as late as at eighty-two years.⁷ It is much the more frequent in males—in the proportion of three to one, according to some compilations, and in much greater proportion according to others. This preponderance has suggested an impression⁸ that the larynx of the male may be subject to some undetermined influence which in females diverts carcinoma to the uterus. Possibly the pleasures of the table, the vices of the tavern, the greater use and abuse of the voice, and the greater exposure to cold, on the part of men, may be factors in its etiology. A severe cold is often mentioned as the starting-point, and chronic laryngitis certainly precedes the disease in many cases. Traumatism is an occasional exciting cause.⁹

Benign growths are sometimes followed by malign ones; occasionally in apparent recurrence,¹⁰ occasionally as the direct result of intra-laryngeal meddling, occasionally as the apparent result of long-continued irritation in the functional activity of the larynx. Gussenbauer¹¹ has had occasion to excise the larynx, for recurrent carcinoma, from an individual in whom twenty years before Czernak had detected, laryngoscopically, a small, circumscribed

¹ Sands, New York Med. Journ., p. 110. 1875; Desnos, Bull. de la Soc. d'Anat., 4e sér., t. iii, p. 398. 1878. (Cited by Butlin.)

² Fauvel (op. cit., p. 689) reports 16 cases of epithelioma and 19 of encephaloid, out of a total of 37 cases of primary carcinoma, the nature of two of which was doubtful.

³ Op. cit., p. 36.

⁴ Cohen, Transactions of the American Laryngological Association, p. 113. 1883.

⁵ Dufour, Bull. de la Soc. d'Anat., p. 53. 1865.

⁶ Rehn, Virchow's Archiv, Bd. xliii, S. 129. 1868.

⁷ Preisendoerfer, Berliner klin. Woch., Nos. 43 und 48. 1878.

⁸ Fauvel, op. cit., p. 696.

⁹ Demarquay, cited by Blanc (Étude sur le cancer primitif du larynx, p. 57. Paris, 1872); Cohen, Transactions of the Pathological Society of Philadelphia, vol. vii, p. 82. 1879; Transactions of the American Laryngological Association, vol. v, p. 117. 1883.

¹⁰ Clinton Wagner, Archives of Laryngology, April, 1883, p. 130.

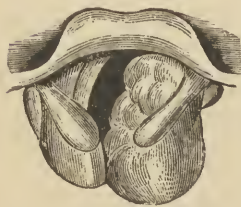
¹¹ Prager medicinische Wochenschrift, No. 31, 1883.

nodule on a vocal band, and had explained to the patient that an operation would be eventually necessary, and from whom, some ten years afterwards, the neoplasm had been removed by Stoerk.

Symptoms.—Dysphonia is usually the earliest symptom to attract attention, sometimes existing for many months, even for two years or more, before any alarm is experienced. Then follow pain, in many instances extending towards the ears and along the neck; dysphagia, when the disease occupies or mounts the upper border of the larynx; cough; salivation; expectoration, which becomes bloody, and perhaps fetid, after the ulcerative stage has commenced; and dyspnoea, proportionate to the mechanical obstruction present. The dysphonia may augment to aphonia. Paralytic aphonia is indicative of nerve-compression. Apparent paralytic aphonia may be due to immobility of a vocal band caused by pressure from a tumor beneath it. In extrinsic carcinoma, the dysphagia precedes the dysphonia. The dysphagia may augment to positive aphagia. Both dysphagia and dysphonia may be due to collateral œdema. The dyspnoea is usually greater in inspiration than in expiration, and often undergoes paroxysmal increase, especially at night. Spasm is an occasional phenomenon. When the tumor has attained sufficient size, the dyspnoea may augment sufficiently to threaten suffocation; but should losses of tissue take place by suppuration and expectoration, these respiratory phenomena become less intense, or subside altogether, and sometimes the aphonia undergoes amelioration likewise. Finally, emaciation, fever, and marasmus ensue.

Diagnosis.—The subjective symptoms are insufficient to establish the diagnosis. The somewhat characteristic shooting pains are sometimes produced in other affections, and are absent in many cases of carcinoma. Laryngoscopically, a diffuse swelling in a circumscribed locality is the earliest objective indication, but this is insufficient for correct diagnosis. Subsequently a distinct tumor becomes developed, undergoes nodulation, and then ulceration. In some instances, chiefly those of extrinsic carcinoma, the progress of the disease is attended with swelling, first of the submaxillary, and then of the cervical lymphatic glands. Finally, the usual carcinomatous cachexia becomes evident; but less pronounced than with carcinoma elsewhere. Thus the disease must usually be of some months' standing before diagnosis by mere inspection can be accurate. Squamous-celled carcinoma is usually first recognizable as an undischored, globose swelling; afterwards it becomes pale, wrinkled, and nodulated. It is apt to become overlaid with papillomatous excrescences, especially when occupying the vocal bands. Large spheroidal-celled carcinoma is usually first recognizable as an undischored,

Fig. 1178.



Large spheroidal-celled carcinoma at an early stage.

irregular, and uncircumscribed tumor; soon becoming nodulated, dark, and irregularly vascular, and finally undergoing ulceration at one or more points. In the advanced stages of the disease there is little difficulty in the diagnosis. The characteristic irregular, nodulated, vascular and ragged aspect of the surface, leaves little room for doubt. And even this doubt can be cleared away by microscopic examination of fragments removed for the purpose; a harmless practice which should be instituted at the very earliest opportunity as a guide for proper treatment. Discrimination between the varieties of carcinoma is otherwise impossible in their early stages. In the ulcerative stage of intrinsic carcinoma of moderate dimensions, or of carcinoma of the epiglottis, the disease is liable to be mistaken for syphilis, and, perhaps, for tuberculosis.

Prognosis.—This is unfavorable. Recurrence is almost inevitable, no matter what the surgical procedure adopted. The small spheroidal-celled variety progresses with the least, and the large spheroidal-celled with the greatest rapidity, the squamous-celled being intermediate. The average term of life, without operation, in the last variety, varies from two to four years. Intrinsic carcinoma affords a much better chance of prolonging life by surgical interference than extrinsic carcinoma, which is practically hopeless. Death may take place by sudden apnœa, asthenia, hemorrhage, collapse, or pyæmia. Tracheotomy, performed when the dyspnœa begins to be urgent, not only ameliorates suffering, but prolongs existence. According to Fauvel's statistics, derived from his own practice,¹ life is prolonged by tracheotomy to much the longest time in the squamous-celled variety. Thus 7 patients with "encephaloid cancer" lived, without operation, for an average of 3 years, while 8 on whom tracheotomy was performed averaged 3 years and 9 months; and 6 patients with "epithelioma" lived without operation for an average of one year and 9 months, while 7 after tracheotomy averaged 4 years. The parity in numbers gives these statistics a special value. Some observers claim that early tracheotomy, although not indicated by progressing dyspnœa, prolongs life as a remedial agent. After the formation of an artificial opening and the removal of obstructing masses, whether through the mouth or through the wound, the recurring growth may force its way to the exterior through the latter, or, as I have seen after low tracheotomy, it may rupture an intact crico-thyroid membrane, and split the thyroid cartilage to give exit to its outgrowths.

Treatment.—Radical treatment involves surgical interference. Whether this should be instituted, will depend upon the extent of the disease, the vigor of the patient, and the opportunities for attention after the operation. Extrinsic carcinoma offers no prospect for cure, even though the larynx be extirpated. Intrinsic carcinoma, as yet confined to the larynx and without lymphatic involvement, may justify laryngectomy; inasmuch as consecutive disease in other parts is, to say the least, infrequent. The prospects are by far the best when the disease is unilateral and occupies but a limited portion of the larynx, so that partial exsection will suffice for complete riddance. (See section on laryngectomy.) At the meeting of the Deutschen Gesellschaft für Chirurgie, in 1884, E. Hahn, of Berlin, called attention² to the fact that in eleven half sections of the larynx for carcinoma, only one patient perished from the operation, while recurrence seemed no more frequent than after total extirpation, and the preservation of functions was so good that in most instances the canula could be definitively removed. It is quite probable, however, that, taking cases as they run, more benefit is to be anticipated to the greater number of sufferers, by prophylactic tracheotomy and the institution of palliative measures, constitutionally and topically. The patient should take care not to use his voice too frequently, and to avoid all risks of exciting laryngitis. The administration of arsenic is believed to have some slight modifying influence on the cachexia. Ergot is indicated to restrain hemorrhage; anodyne inhalations and insufflations of morphine diminish pain; weak solutions of silver-nitrate sometimes obtund the sensitiveness of the parts; aromatized sprays cleanse them from mucus and pus; and disinfectant sprays control the unpleasant odor. Dyspnœa requires rest of part and body. Semi-detached portions of growth impeding respiration, may be removed with forceps, and the raw surface may be subjected to slight cauterization. Under other conditions, mechanical interference is to be deprecated. When suffocative

¹ Op. cit., p. 717.

² Beilage zum Centralblatt für Chirurgie, No. 23, S. 55. 1884.

apnœa is threatening, tracheotomy is indicated, and should be performed at as great a distance below the disease as practicable. Dysphagia necessitates the use of semi-fluid or fluid nourishment. When aphagia is threatening, rectal alimentation should be resorted to in advance of its absolute necessity. Dysphagia due to an enlarged and ulcerated epiglottis may be overcome by ablation of that organ, a procedure which in my own practice has been followed with no unpleasant results, and has afforded considerable comfort. In disease limited to the epiglottis, excision of that structure after sub-hyoidæan incision externally, is indicated as a radical measure.

The question as to the propriety of laryngectomy bids fair to be duly answered in the near future. Nearly eighty complete extirpations of the larynx are known to have been performed for carcinoma. The ultimate results, as far as can be ascertained, are herewith presented :—

From all sources, published and unpublished, I am able to present the following :—

RECORD OF DEATHS REPORTED AFTER COMPLETE LARYNGECTOMY FOR CARCINOMA.

Operator.	Death in	36 hours from	Cause of death.
Tilanus.	"	collapse.	
Macewen.	" 3 days	"	pneumonia.
Bottini.	" 3 "	"	"
Langenbuch.	" 3 "	"	collapse.
Schmidt.	" 4 "	"	"
Gerdes.	" 4 "	"	"
Billroth.	" 4 "	"	pneumonia.
Toro.	" 4 "	"	pulmonary emphysema.
Schönborn.	" 4 "	"	"
Hodgen.	" 4 "	"	?
Bergmann.	" 4 "	"	pneumonia.
Multanowski.	" 5 "	"	pneumonia.
Reyher.	" 5 "	"	septic broncho-pneumonia.
Pick.	" 5 "	"	pleurisy and pericarditis.
McLeod.	" 5 "	"	secondary hemorrhage.
Maydl.	" 5 "	"	severe arterial hemorrhage.
Reyher.	" 7 "	"	septic broncho-pneumonia.
Reyher.	" 7 "	"	septic pneumonia.
Watson.	" 7 "	"	pulmonary embolism.
Thiersch.	" 7 "	"	"secondary infectious" pneumonia.
Vogt.	" 7 "	"	exhaustion.
Albert.	" 8 "	"	"diffuse bronchitis and lobular" pneumonia.
Reyher.	" 11 "	"	"hypostatic" pneumonia.
Reyher.	" 14 "	"	exhaustion.
Maas.	" 2 weeks	"	pneumonia.
Watson.	" 2 "	"	"
Bircher.	" 16 days	"	pneumonia and "pulmonary gangrene."
Hahn.	" 15 "	"	putrid bronchitis.
Novaro.	" 1 month	"	pneumonia.
Hahn.	" 4 weeks	"	suppurative bronchitis and pneumonia.
Hahn.	" 5 "	"	" " " "
Billroth.	" 6 "	"	passage of bougie into mediastinum.
Multanowski.	" 2 months	"	recurrence.
Gussenbauer.	" 2 "	"	tuberculosis pulmonum.
Winiwarter.	" 9 weeks	"	inanition.
Multanowski.	" 3 months	"	"croupous" pneumonia.
Langenbeck.	" 4 "	"	recurrence.
Thiersch.	" 4 "	"	"
Novaro.	" 4 "	"	recurrence and hemorrhage consequent upon additional operative procedures.
Holmer.	" 4 "	"	recurrence.
Leisrink.	" 4 "	"	croupous pneumonia.
Burow.	" 4½ "	"	sudden suffocation.
Czerny.	" 5 "	"	recurrence.
Volker.	" 5 "	"	suffocation.
Heine.	" 6 "	"	recurrence.
Maas.	" 6 "	"	"
Margary.	" 6 "	"	profuse hemorrhage due to recurrence with extensive ulceration.

Operator.	Cause of death.			
Billroth.	Death in	7 months	from recurrence.	
Holmer.	"	7	"	"
Novaro.	"	8	"	suffocation by pen (quill?) which had slipped into trachea. No recurrence.
Bruns.	"	9	"	recurrence.
Kosinski.	"	9	"	"
Reyher.	"	9	"	"
Novaro.	"	13½	"	? ("Sudden.")
Czerny.	"	15	"	recurrence.
Czerny.	"	18	"	"
Kocher.	"	2 years	"	cancerous disease of abdomen. No local recurrence.
Thiersch.	"	2½	"	recurrence.
Durante.	"	2 or 3 days.		
Holmes.	"	40 hours	from collapse.	

In marked contrast to the table of deaths, it is pleasant to turn to the following record, which shows remarkably happy results in patients who, as did five in the above list, survived the operation longer than one year, and all of whom are possibly still living:—

Name of operator.	Latest report of patient.			
Thiersch.	Patient living	3 years and 7 months	after operation.	
Winiwarter.	"	3	"	"
Novaro.	"	2	"	3
Hahn.	"	2	"	"
Gussenbauer.	"	2	"	over
Gussenbauer.	"	1 year and 9 months	"	"
Maydl.	"	1	"	4
Kocher.	"	1	"	4

Professor Schede has been kind enough to write me concerning two additional laryngeotomies recently performed by him, under conditions such as to justify expectation of highly satisfactory results. In addition, it may be stated that there are twelve cases, published and unpublished, the subjects of which are noted as living at periods varying between five weeks and nine months after the operation.

From the record presented, it is evident that life may be prolonged in some individual cases of carcinoma for periods sufficient to justify laryngectomy. It is incumbent upon surgery, therefore, to eliminate the elements of failure, so that the procedure may be confined to cases of promise. A vigorous individual, with an intrinsic carcinoma as yet untrenching upon contiguous structures, and exhibiting no evidence of lymphatic involvement, may be a proper subject for the operation. But despite the exceptional cases cited, the general prospect, on the score of the greatest good to the greatest number, hardly looks more encouraging than it did when I recently made it the occasion of a special investigation.¹

MORBID GROWTHS OF THE TRACHEA.

BENIGN GROWTHS.—The trachea may become the seat of every variety of benign neoplasm. As shown by the subjoined table of reported instances of veritable neoplasms, such growths are more frequently situated on the membranous portion than on the cartilaginous, and are more frequent in the upper portion than in the lower. Quite a number occur at the bifurcation. Some are associated with similar growths in the larynx, some with growths in the bronchi, and occasionally one with growths in the œsophagus; some, especially ecchondromata and osteomata, are associated with tuberculosis. Adults are affected more than children, and males more than females. The causes are obscure. The meagre records of the patients' occupations furnish no clew in that direction.

¹ Does Excision of the Larynx tend to the Prolongation of Life? (Transactions of the College of Physicians of Philadelphia, 1883.)

CASES OF INTRA-TRACHEAL BENIGN TUMOR.

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
1	Butlin,	Laryngo-tracheoscopically	F. 38	Large-grained papilloma.	Left site for half the circumference of trachea extending for an inch below cricoid cartilage.	Tracheotomy and evulsion with finger-nail.	Cure.	St. Bartholomew's Hosp. Reports, p. 129, 1882.	The tumor was not discovered until after several examinations, when patient had become more tractable.
2	Chiari,	At autopsy	F.	Osteoma.	A lamella 4 cm. x 3 cm. x 3-4 mm.	.....	.....	London Med. Record, July 15, 1878. Mackenzie, op. cit., vol. i, p. 526.	Dead of acute tuberculosis; minute formations of singular character in bronchi.
3	Clark (A.),	At autopsy	F. 75	Lymphadenoma.	Mucous surface of trachea covered with small growths.	.....	.....	Med. Times and Gaz., Dec. 13, 1873, p. 679.	Tracheotomy had been twice performed. A tumor was found behind the trachea and to either side, in addition to the small growths in the interior.
4	Cohen,	At autopsy	M.	Multiple echondroma.	Anterior wall.	.....	.....	Trans. Patholog. Soc. Phila., vol. iv, p. 144, 1874. Unpublished.	Patient had died of ulcerative tuberculous laryngitis, with perichondritis, abscess, and necrosis.
5	Cohen,	Tracheoscopically	M. 6	Multiple papilloma.	Posterior wall, about opposite 2d, 3d, and 4th rings.	Evulsion with forceps and finger-nail through tracheal incision	Probable cure. No unsatisfactory report since operation.		Tracheotomy performed for multiple laryngeal papillomata when patient was apparently dying; subsequently, thyroid laryngotomy to extirpate growth. These operations by Dr. Davis, of Denver, Col. A second thyroid laryngotomy by myself two years after, and thorough evulsion with forceps, finger-nail, and sharp spoon. Recurrence in trachea three months after; stricture of larynx at clink of glottis, requiring retention of tracheal cannula, although a No. 22 French bougie could be readily passed.
6	Eppinger,	At autopsy	M. 23	Fibroma.	Posterior wall, 4.5 cm. above bifurcation; size of filbert.	.....	.....	Kiebs, op. cit., Bd. ii. Abth. 1, S. 296.	

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—Continued.

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
7	Eppinger,	At autopsy	.....	Multiple osteoma.	Anterior wall.	.....	.....	Ibid., S. 299.	
8	Eppinger,	At autopsy	.....	Multiple osteoma.	Anterior wall.	.....	.....	Ibid.	
9	Eppinger,	At autopsy	.....	Multiple polypoid cystadenoma.	Posterior wall.	.....	.....	Ibid., S. 300.	
10	Fifield,	At autopsy	F.	"Pedunculated rosypolyp," (Fibroma?)	Bifurcation; size of grape.	Expectant.	Death by suffocation.	Boston Med. and Surg. Jour. Nov. 14, 1861.	
11	Flormann,	At autopsy	M. 30 boatman.	.....	Size of walnut; almost entire posterior upper portion, stretching to cartilages.	.....	.....	Schwedische Abhandl., Bd. iv. No. 7. 1790; cited by Lewin (Deutsche Klinik, No. 20, S. 192. 1862.)	Necrosis of several tracheal cartilages.
12	Fournié,	Brought to tracheal orifice by cough	F. 17 servant.	Multiple mucous polypi. (Myxomata?)	Below tracheal incision. One, size of a filbert, others smaller.	Two removed with forceps through tracheal orifice; one with a <i>serre-neud</i> .	Cure.	Gaz. des Hôp., No. 56. 1868.	Patient was brought to Hotel Dieu, semi-asphyxiated. Tracheotomy. Evulsion of laryngeal polyp through mouth. Afterward operations described.
13	Gerhardt,	.....	.....	.....	.....	.....	.....	Allg. Wien. med. Ztg., No. 33. 1861. (Koch.)	
14	Gerhardt,	.....	.....	Ecdiondroma.	.....	.....	.....	Jenaischen Zisch. f. Med. u. Naturwiss., Bd. iii. S. 134. 1867. (Koch.)	Supposed to have been of inflammatory origin.
15	Gibb,	Laryngoscopically	F. adult.	Cystoma.	Anterior wall.	Expectant.	Spontaneous rupture.	Diseases of Throat, p. 392. London, 1864. Gaz. des Hôp., 1870. Eppinger.	
16	Krishaber,	.....	.....	Fibroma?	.....	.....	.....

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—Continued.

No.	Observer.	How detected.	Sex, age, and occupation.	Histology	Location and size.	Treatment.	Result.	Reference.	Remarks.
17	Labus,	Laryngoscopically	M. 13 worker in woolen and cotton stuffs.	Fibro-sarcoma.	Upper rings left lateral and posterior wall. Little larger than a pea.	Evulsion with forceps, <i>per vias naturales</i> .	Cure (seen 4 months afterwards).	Archives of Laryngology, p. 220. 1880.	
18	Labus,	Laryngoscopically	M. cheese-maker	Multiple papillary epithelioma (papilloma?)	At 5th, 8th, and 9th rings.	Evulsion <i>per vias naturales</i> .	Cure.	Arch. Ital. di Lar. p. 9. 1881.	
19	Lientaud,	.....	M. 12	"Pedunculated polyp." (Fibroma, Epipinger.)	Upper third.	.....	.....	Historia. Anat. Med., lib. iv. obs. 64. Gothae, 1802; cited by Lewin (loc. cit.).	
20	Maisonneuve,	.....	10½	Papilloma.	Inner surface.	.....	.....	Rauchfuss (Gerhard's Hdbch., f. Kind., Bd. iii. H. 2, S. 269); cited by Epipinger.	
21	Mackenzie,	At autopsy	F. 72	Papilloma.	Size of a bean.	None.	.....	Brit. Med. Journ., May 30, 1874, p. 710.	Patient died of congestion of the lungs. Thyrotomy had been performed eight years previously for removal of laryngeal papilloma, a recurrent tumor having been removed in fragments through the mouth.
22	Mackenzie,	Laryngoscopically	M. 43	.....	2d and 3d rings; size of a bean.	Touched with electric cautery point.	Cure.	Op. cit., vol. i. p. 525.	
23	Mackenzie,	Laryngoscopically	F. 22	.....	3d ring; size of a pea.	A single unsuccessful attempt with electric cautery.	.....	Ibid.	

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—Continued.

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
24	Mackenzie,	Laryngoscopically	M. 37 clerk.	.....	1st and 2d rings; size of a white currant.	Touched with electric cautery.	Cure.	Ibid.	
25	Mackenzie,	Laryngoscopically	M. 45	"Bright red polypus."	4th, 5th, & 6th rings anteriorly. Size of a grape.	Tracheotomy proposed and refused.	Sudden death, probably by suffocation.	Ibid.	
26	J. N. Mackenzie (Baltimore),	At autopsy	M. adult.	"Tubercular tumor."	Posterior membranous wall 1½ cm. above bifurcation; well defined and circumscribed. Size of a small bean.	.....	.....	Archives of Medicine, No. 2, 1882.	Patient had died of carcinoma of stomach, with secondary deposits in several organs. Lungs contained tuberculous cavities; pharynx, larynx, and trachea free from inflammation and ulceration. Before microscopic examination the tracheal tumor was supposed to be a hard cancerous nodule.
27	Melion ?	.....	.....	.....	.....	.....	.....	Oesterreich. med. Ztschr., No. 10, 1864. (Koch.)	A questionable case.
28	Meyer-Hüni,	Laryngoscopically	M. 27 farmer.	Fibro-sarcoma.	Left side about 3d or 4th ring. 21x18x11 mm.	Incision into trachea and removal with scissors.	Recovery (well 2 months after).	Correspondenzblatt für Schweizer Aerzte, 1 Mai, 1881; Medical Record, Nov. 12, 1881, p. 543.	
29	Ozanam,	Laryngoscopically	F. 39	2 "polypes," rosy white and mammillated.	Symmetrically, posteriorly, at point of junction of larynx and trachea.	Evisulsion with guillotine.	Cure.	Gaz. Méd. de Paris, No. 27, 1863, p. 441.	Possibly growths on inferior surface of arytenoids as they accompanied the movements of the latter; but as papillomata are exceedingly rare in the posterior portion of the larynx, and most frequent in the posterior portion of the trachea, the example is included as a doubtful case.
30	Rokitansky,	.....	.....	Fibrona.	Above bifurcation.	.....	.....	Wien. Ztschr., Bd. vii. S. 181; cited by Eppinger. Lehrbuch u.s.w., 3 Aufl., Bd. iii. S. 25.	

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—*Continued.*

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
31	Rokitansky,	.....	M. 85 clergyman.	Lipoma, pedunculated, size of hazelnut.	Bronch. branch of left lower lobe, just above its division.		Sudden death in collapse.	Cited by Lewin (op. cit., S. 193).	
32	Schroetter,	Laryngoscopically	M. 34 house-painter.	Papilloma, with recurring sarcoma.	Anterior wall; region of 4th tracheal ring. Recurrent tumor at posterior portion of right side and at posterior wall.	Injections of ferric chloride causing shrinkage; posterior evulsion with forceps in relation of curvature.	Reurrence.	Medizinischer Jahrbücher, Bd. iii. S. 64. Wien, 1868. Jahresbericht der Klinik für Laryngoskopie, S. 80. Wien, 1871; <i>Ibid.</i> , S. 102. 1872.	
33	Smith, A. H.	During tracheotomy	F. 14	"Inflammatory fibrinous growth."	Upper portion right side, leaving only a small passage for air at left and posteriorly.	Canula forced past obstruction.	Diphtheria supervened, with death in 4 days.	Am. Journ. Med. Sci., July, 1876.	Seems to have started in an acute laryngo-tracheitis while convalescing from measles.
34	Smoler,	.....	.....	.....	.....	.....	.....	Allg. Wien med. Ztg., No. 33, 1861. (Koch.)	
35	Stallard,	At autopsy	F. 40	Pedunculated polypus. (Fibroma, Eppinger.)	Half an inch beneath cricoid cartilage, at anterior portion: size of an almond; pedicle $\frac{3}{4}$ inch long.	Expectorants for asthmatic bronchitis.	Sudden death after violent paroxysm of cough.	Lond. Med. Gaz., N. S., vol. ii. p. 275. 1842-3.	Lungs emphysematous; smaller bronchi healthy; primitive bronchi highly congested. Polypus found loose in the trachea, but a portion of the pedicle remained attached at point indicated.
36	Stenier,	.....	.....	.....	.....	.....	.....	Jahrb. f. Kinderheilkde., 1856; cited by Eppinger.	
37	Stendener,	At autopsy	.....	Multiple osteoma.	1-1 $\frac{1}{2}$ mm.; in the mucous membrane.	.....	.....	Virehow's Archiv, Bd. xiii. S. 48; cited by Eppinger.	Patient died of otitis interna with cerebral involvement.

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—*Concluded.*

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
38	Stoerk,	Laryngoscopically	M. 22	Multiple papilloma.	Third ring.	Tracheotomy declined.	.....	Stoerk, op. cit., S. 438.	Associated with multiple papilloma of larynx.
39	Stoerk,	Laryngoscopically	M.	Multiple papilloma.	.....	Tracheotomy declined.	.....	Ibid., S. 439	Associated with multiple papilloma of larynx.
40	Stoerk,	Laryngoscopically	F. 40	Fibroma.	Posteriorly, size of bean.	Tracheotomy declined.	.....	Ibid.	
41	Stoerk,	Laryngoscopically	M. 42	Vascular papilloma.	Just above bifurcation.	Entire trachea laid open longitudinally and evulsed with sharp spoon. (Billroth operator.)	Recovery.	Ibid., S. 440; Billroth, Clin. Surg., p. 134. London, 1881.	Recurrence; repetition of former operation; removal of a small granuloma at site of former growth; a resistant mass along the right side of trachea reaching to the sternum and compressing trachea; introduction of a canula reaching to the bifurcation; this pressed external tumor aside and eventually caused its disappearance.
42	Tuerck,	At autopsy	M. 37	Fibroma.	Posterior wall, upper portion. 6 x 2 x 4 mm.	.....	.....	Op. cit., S. 502, Wien, 1860.	Patient had died of pulmonary tuberculosis. At about central portion of tumor, a second roundish and more pedunculated tumor projected backward into the oesophagus.
43	Tuerck,	Laryngoscopically	M. 38 waiter.	Fibroma? (Eppinger.)	Posterior wall, upper portion. Size of small sugar-corn.	None.	.....	Ibid., S. 503.	A doubtful case. But for its seat posteriorly, might have been laryngeal; no functional disturbance.
44	Tuerck,	Laryngoscopically	F. 38 waitress.	Multiple fibroma? (Eppinger.)	Right wall, very low down, one size of a hemp-seed, another smaller one near first. Several minute growths at commencement of left bronchus.	None.	.....	Ibid.	
45	Wilks,	At autopsy	? 38	Multiple osteoma.	Anterior wall; small, submucous, intercartilaginous.	.....	.....	Trans. Path. Soc. London, vol. vii. 1857; cited by Tuerck and by Mackenzie.	Patient had died of phthisis; similar formation in bronchi.

Granulomatous Formations.—Pedunculated polypoid vegetations, rarely larger than peas, sometimes occur upon the intra-tracheal cicatrix, usually within two months after closure of the wound of tracheotomy. Microscopically, they are similar to the cauliflower excrescences, or exuberant granulations, which so often occur around the edges and along the track of the wound, while the canula is in position, when the parts are not properly dressed—or which occur upon ulcerated portions of the mucous membrane under attrition by the tube—but they seem to acquire an epithelial investment sometimes covered with cilia. While histologically not veritable neoplasms, they may be regarded clinically as benign tumors, inasmuch as they produce the same symptoms, present the same dangers, and require the same treatment—namely, incision into the trachea, thorough evulsion, and cauterization of their points of implantation. They may even be reproduced on the second cicatrix, and thus necessitate a third tracheotomy.¹ These growths are sometimes described as polypi. They have been especially studied by Petel.²

Krishaber, St. Germain, Verneuil, and others, believe that these formations proceed from intact mucous membrane, and thus antedate the tracheotomy. Millard and Harvey, and other observers, contend that they originate in blood-clots which become adherent. In a case communicated to me by Dr. A. H. Smith, of New York, a deep-pink growth, the size of a currant, was seen, apparently attached to the left side of the cicatrix, six weeks after the tracheotomy. Streaks of blood appeared in the expectoration, and after quite a large clot of dark blood had been coughed up, the breathing became easy; and, on laryngoscopic examination, the growth was found to have disappeared. Petel records a growth discovered upon the tracheal surface of a tracheotomy-cicatrix in the body of a man, sixty-nine years of age, who had committed suicide, but concerning whose previous history no details could be learned.

The much more frequent granulomatous vegetations occurring after tracheotomy, have been discussed in connection with croup and diphtheria, among the causes which prevent early removal of the canula (page 307). They have been elaborately studied by Koch.³

MALIGN TUMORS.—Sarcoma and Carcinoma.—As will be seen by the first of the subjoined tables, short as it is, *sarcoma* seems to occur in the trachea with greater proportionate frequency than it does in the larynx; for the thousands of laryngeal growths reported include few sarcomata. The apparent preponderance may be due to the circumstance that laryngeal growths, being much more common, are less frequently reported or submitted to minute examination, and that thus some laryngeal sarcomas go unrecognized. The recorded cases of fibro-sarcoma, two in number, having been cured without resort to radical measures, have been tabulated among those of benign growth. *Carcinoma* of the trachea is rare as a primary disease, the cases collected in the second of the subjoined tables comprising all at my immediate command. It will be observed that it is most frequent in the upper portion of the tube, that it is most frequently located on the membranous wall, and that it is sometimes associated with primitive carcinoma of the bronchi. The records are too meagre to show the comparative frequency of the different varieties. Males and females seem to be susceptible in equal proportions, and all the instances recorded have occurred in adults.

¹ Koch, Archiv für klinische Chirurgie, Bd. xx. S. 542. 1877.

² Des Polypes de la Trachée. Paris, 1879.

³ Loc. cit., S. 540–558.

CASES OF INTRA-TRACHEAL SARCOMA.

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
1	Eppinger,	At autopsy.	.....	Lympho-sarcoma.	Above bifurcation; hemi-spheroidal; size of a nut.	.....	.....	Op. cit., S. 298.	Started from a sarcoma of bronchial gland, which had penetrated the soft tissues of trachea.
2	Schroetter,	Laryngoscopically.	F., 19.	Sarcoma.	Right wall.	Injection of ferric chloride by an inexperienced hand.	Death under operation.	Laryngologische Mittheilungen, S. 102. Wien, 1875.	After refusing treatment from Schroetter, the patient fell into other hands.
3	Schroetter,	do.	M., 34. House painter.	Sarcoma.	.....	.....	.....	See case No. 32, in table of benign growths.	

CASES OF PRIMARY INTRA-TRACHEAL CARCINOMA.

No.	Observer.	How detected.	Sex, age, and occupation.	Location.	Histology.	Treatment.	Result.	Reference.	Remarks.
1	Delafield,	At autopsy	F., 27.	Small portion of lower part.	Squamous-celled (apparently epithelial cancer).	.....	Death from suffocation.	New York Med. Journ., vol. xxxvi. p. 406. 1882.	In connection with similar disease nearly obliterating the primitive bronchi. Dyspnoea supposed to be aneurismal.
2	Isambert,	Laryngoscopically.	M. "old." Journalist.	High up "some distance below right vocal band."	.....	Tracheotomy in emergency.	Death despite the tracheotomy.	Conférences Cliniques sur les Maladies du Larynx, etc., pp. 257-9. Paris, 1877.	Result of examination after death refused by the interne of the hospital where it took place.
3	Isambert and Krishaber,	Laryngoscopically.	M. ? Manufacturer.	Deeply situated.	.....	Electric cautery, producing need for immediate tracheotomy.	Death in dyspnoea on third day.	Ibid., pp. 259-61.	Cancerous tumor found in the portion of trachea removed at autopsy, cut off above the point of insertion. Specimen presented to the Société de Chirurgie, in 1874.

CASES OF PRIMARY INTRA-TRACHEAL CARCINOMA.—*Concluded.*

No.	Observer.	How detected.	Sex, age, and occupation.	Location.	Histology.	Treatment.	Result.	Reference.	Remarks.
4	Klebs,	At autopsy	.....	.....	Cylindrical-celled.	.....	.....	Friedreich; cited by Eppinger (Klebs, op. cit., Bd. ii. Ab. 1, S. 301).	
5	Koch,	.....	F., 37. Servant.	.....	Large spheroidal-celled. "Markschwamm."	.....	.....	n. Geburtshelfer, Bd. xxi., 1868; cited by Eppinger.	
6	Langhans,	At autopsy	M., 40.	Bifurcation. Posterior and lower; 7 mm. thick, extending $2\frac{1}{2}$ cm. into right bronchus.	Small polygonal or cylindrical celled (nested).	.....	.....	Virehow's Archiv, Bd. liii. S. 470. 1871.	Originating in the mucous glands, and associated with primitive carcinoma of the bronchi.
7	Mackenzie (April, 1864),	At autopsy	F., 87.	Middle third; originating from 3 sides, chiefly the posterior, and extending to within half an inch of the cricoid cartilage.	Squamous-celled (typically epithelial).	.....	Death (Jan. 1865).	Op. cit., vol. i. p. 529.	Great tracheal stenosis.
8	Morra,	At autopsy	M., 62.	Upper portion of posterior and lateral wall.	"Medullary."	.....	.....	Giorno. Intern. dell. Scien. Med., Nos. 10-11, 1879, p. 1129.	Paralysis of laryngeal abductor noted during life. Growth associated with carcinoma of both lobes of thyroid gland.
9	Rokitansky,	At autopsy	F.	Upper posterior portion to an extent of 2 inches. Posterior wall from 3d to 5th rings.	Large spheroidal-celled? "Markige Geschwulstmasse." "Ulcerating."	.....	.....	Friedreich; cited by Eppinger.	
10	Schroetter (May, 1869),	Laryngoscopically.	M., 56.			Expectant.	Repeated hæmoptysis. (July, Aug., Sept.) Death in Sept. hours.	Laryngologische Mittheilungen, S. 86. 1871.	
11	Schroetter (May, 1871),	.....	M., 51.	Posterior and right lateral wall.	Small spheroidal-celled (fibrous), red and blue roundish masses, from size of seeds to that of beans.	Tracheotomy.	Death in 4 hours.	Ibid., S. 102. 1875.	

Secondary carcinoma seems still more rare, the only record at command being an instance of primary carcinoma in the upper third of the œsophagus, reported by Eppinger,¹ in which a roundish, metastatic nodule, the size of a walnut, was developed at the bifurcation, half of it projecting inward into the lumen of the trachea, and the other half being imbedded between the trachea and the œsophagus. Eppinger mentions also that disseminated melanotic patches occur in the tracheal mucous membrane as metastases from primary melanotic carcinoma of the skin.

Carcinoma of the trachea in extension of carcinoma of contiguous organs, is by no means infrequent. These extensions occur from the œsophagus, the larynx, the thyroid gland, the bronchial glands, and the bronchi. Ulceration is most frequent in cases progressing from the œsophagus and the larynx, and fistulous communication between the trachea and œsophagus is not rare. A carcinoma of the two tubes may attain great dimensions, sometimes imbedding the common carotid artery, the jugular vein, the pneumogastric nerve, and the pleura.²

Symptoms of Intra-tracheal Tumors.—There are no symptoms specially indicative of a growth in the trachea, unless it becomes large enough to interfere mechanically with respiration, and to produce intense cough, dyspnœa, and even stridor. Harsh, dry, persistent cough has in some instances preceded the labored respiration and stridor, and it is quite probable that dry, sonorous *râles* are among the earliest symptoms. The voice is sometimes much impaired in strength by reason of the limited volume of the expiratory current. A forward position of the head has sometimes a marked influence in ameliorating the intensity of the symptoms, and the recumbent position may become unendurable. The intensity of the dyspnœa depends much on the mobility, size, and location of the growth. It is sometimes suffocative. In Dr. Fildes's³ case, a primary pedunculated growth the size of a grape, and attached to the trachea at the mouth of the bronchus, closed the left bronchus to the inspiratory current as with a pea-valve. Mackenzie⁴ records a case in which a similar polypus covered the 4th, 5th, and 6th rings anteriorly, and in which death was sudden. Stallard⁵ reports a case in which sudden death ensued after a fit of coughing. Quite large growths however may exist without symptoms sufficiently significant to suggest laryngoscopic examination.⁶ The symptoms may simulate those of aneurism.⁷

The symptoms of sarcoma are similar to those of benign growths. Those of carcinoma embrace usually pain and the symptoms of stricture of the trachea in addition. In carcinoma by extension, these become superadded to the earlier symptoms of disease in contiguous organs, especially dysphagia, from carcinoma of the œsophagus, and dysphonia or aphonia, from pressure on the recurrent laryngeal nerves.

Diagnosis.—This is possible only by laryngo-tracheoscopy, or by inspection or palpation through a tracheal wound. It is probable that the outline of a tumor might be detected by strong transmitted illumination from the exterior (method of Massei). In the laryngoscopic image, a tumor is seen below the cricoid cartilage. If obscured by the presence of a laryngeal growth, dyspnœa continuing after removal of the latter may lead to a correct diagnosis.⁸ But little can be inferred from inspection as to the nature of the

¹ Klebs, op. cit., Bd. ii. Abth. 1, S. 302.

² Wood, Brit. Med. Jour., Feb. 25, 1871, p. 196.

³ Boston Med. and Surg. Journal, Nov. 14, 1861; cited by Gibb.

⁴ Op. cit., vol. i. p. 525.

⁵ Tuerck, op. cit., S. 502.

⁶ Loc. cit.

⁷ Delafield, loc. cit.

⁸ Fournié, loc. cit.

growth. Should fragments be expectorated, they can be examined under the microscope. Unless there be no doubt that the growth occupies as deep a position as indicated, a laryngeal growth may be mistaken for a tracheal one. I have known a growth to be described as endo-tracheal, and as situated

Fig. 1179.



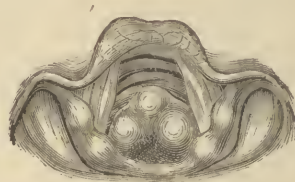
Tracheal tumor seen by laryngoscopy. (Labus.)

Fig. 1180.



The same case after evulsion of the tumor. (Labus.)

Fig. 1181.



Sarcoma of trachea. (Schroetter.)

at the fourth or fifth ring, which had been described by myself as an endolaryngeal growth, not below the level of the cricoid cartilage. It is necessary also to be able to exclude involutions of the trachea (see Fig. 1134, page 280), whether from aneurism or from growth outside the air-tube, giving rise to similar physical symptoms. Occasionally, the pulsation of an aneurism can be detected in the laryngoscopic image.¹

The cases in which polypi, presumed to be tracheal, have occasionally been expectorated, such as those described by Samber² and by Nicholls,³ may not have been cases of tracheal growth, as it is impossible to distinguish expectorated masses as laryngeal or tracheal.

Prognosis.—The prognosis is unfavorable. In cases not subjected to treatment, or subjected to hazardous intra-laryngeal treatment, death may take place by suffocation. In cases subjected to proper surgical procedure—tracheotomy—a benign growth may often be safely removed. The same remark is applicable, to a certain extent, to sarcomas.

Carcinoma, unless exceedingly circumscribed, is necessarily fatal. Death may take place by asthenia, by hæmoptysis, by collapse from perforation, or by gradual or sudden apnoea.

Treatment.—Despite occasional success, attempts to treat a tracheal tumor by operation through the mouth seem to me hazardous, and therefore improper. One death is recorded (see table) from an attempt to inject a solution of ferric chloride—a procedure which in more experienced hands had succeeded in shrivelling the remnants of a growth, portions of which had, at different intervals, been removed with forceps. Previous to manipulations in the successful case, local anæsthesia was produced by pencilling the larynx first with chloroform, and then, at intervals of about an hour, with a solution of morphine-acetate, ten grains to the drachm of water, until the sensibility of the part was sufficiently obtunded. This plan, at one time much in vogue in some localities, preparatory to removals of intra-laryngeal growths, seems to me in the highest degree reprehensible, for dangerous and even fatal narcotism has been reported therefrom. I have never seen the method practised, and have never cared to try it. Gerhardt is said to use colchicin with some satisfaction as a local anæsthetic. As these lines are being written,

¹ Cheesman, Medical Record, Sept. 22, 1883, p. 335.

² Philosophical Transactions, No. 398. 1727; cited by Coxe (Am. Jour. Med. Sci., O. S., vol. iii. p. 243. 1828-1829).

³ Ibid., 1731; Coxe, loc. cit.

favorable reports are being published of the use of cocaine-hydrochlorate as a local anæsthetic, applied to the conjunctival mucous membrane—an agent said to have been previously employed to produce anæsthesia of the mucous membrane of the larynx.¹ Several attempts by myself to produce anæsthesia in the larynx with this agent, have failed to control spasm in the subsequent introduction of instruments, although the sensation of contact was greatly obtunded. In the pharynx and palate the effects are much better. It may be stated parenthetically that both tincture and fluid extract of coca have, during recent years, been occasionally employed by myself as well as by others,² to obtund sensitiveness in hyperæsthesia of the mucous membrane of the pharynx and larynx.

Mackenzie³ records two instances in which one touch to a tracheal growth with the electric cautery-point seemed to remove all vestige of the neoplasm within a week. The fact that in the treatment of laryngeal neoplasms, mere touching with the electric cautery simply scorches the mucous membrane, renders these exceptional results too uncertain to secure approval of the method.

Similar caution is applicable to the use of forceps. The spasmodic closure of the chink of the glottis in the non-anæsthetized larynx, which almost invariably follows its passage by any instrument, must obstruct the view and hinder freedom of manipulation.

The proper method of treating a benign tracheal neoplasm is, when practicable, to incise the trachea at a point sufficiently low to expose the growth, and then to remove it by forceps, sharp spoon, or finger-nail, as may be found most efficacious. The points of implantation should then be cauterized. In the one case to which my personal experience of this measure is limited, the only difficulty encountered was from the bleeding and the spasmodic coughing which rendered the operation unpleasant. It was performed with the head hanging down so that the blood should not flow into the bronchi.

It is well known that the tracheal bifurcation can be reached through the ordinary tracheotomy incision below the isthmus, so that a tumor might readily be attacked in almost any portion of the tube; and, as was done in one of the cases recorded in the table, there seems to be no reason why the incision should not be prolonged down to the very top of the sternum when necessary.

In carcinoma, measures for relief are limited to palliative attempts to reduce suffering to a minimum. Tracheotomy below the seat of disease will afford temporary relief to dyspnoea from obstruction above the incision, and hypodermic injections of morphine will subdue pain. Surgery as yet tenders no prospect of permanent relief by exsection.

LARYNGECTOMY.

The successful exsection of the human larynx has been one of the greatest surgical surprises of the century. In the course of some experiments on dogs, instituted by Albers,⁴ in 1829, to ascertain to what extent the larynx participated in respiration, he removed the entire organ from two animals. One died by hemorrhage from an accidental wound of the carotid; but the other lived for nine days, and died apparently from insufficient nourish-

¹ *Lancet*, Oct. 4, 1884; *Medical News*, Oct. 25, 1884, p. 457.

² Du Cazal, *Rev. Méd. Française et Étrangère*, 19 Nov., 1881, p. 751; also, *Medical Record*, April 7, 1883, p. 384.

³ *Op. cit.*, vol. i. p. 525.

⁴ *Graefe und Walther's Journal für Chirurgie*, 1829.

ment.¹ These experiments were wholly unassociated with any question as to the practicability of such an operation in man. Laugenbeck,² it appears, in 1854, had made favorable mention of the procedure in his *Klinik*. Heuter³ states that some years before 1870 he had entertained the idea of performing the operation upon a vigorous, middle-aged woman, with a canceroid of the mucous membrane in the neighborhood of the arytenoid cartilage; an idea which had occurred likewise to Koeberlé, in 1856,⁴ and which had been both entertained and put in execution by Dr. Patrick Henry Watson, of Edinburgh, in 1866.⁵ To Vincenz Czerny, of Heidelberg, however, belongs the credit of recommending the performance of this operation on the human subject, as the outcome of his own experiments on dogs.⁶

Emboldened by the favorable results of Czerny's experiments, Prof. Billroth, of Vienna, deliberately undertook to perform an operation of the same kind on a man⁷ in whom recurrence had taken place within four weeks of attempted extirpation of a carcinoma after splitting the larynx. After the wound healed, an artificial larynx, another device of Czerny's, constructed according to indications suggested by Gussenbauer, enabled the patient to talk with an artificial, monotonous voice. This patient died about one year after the operation, in consequence of recurrence in the cervical glands, commencing some four months after he had left the *Klinik*.⁸

Since this period the operation has been repeatedly performed, chiefly in cases of carcinoma. (See table, page 353.) A case of suicidal exsection of the larynx, in a woman forty-one years of age, has been recorded by Mr. R. C. Harrison.⁹ Death occurred in twenty minutes.

The second table (page 364) comprises all the records of unilateral laryngectomy to which I have had access. Two cases of "partial excision of the larynx," reported by Foulis,¹⁰ are not introduced, since they were mere excisions of the anterior portion of the cricoid cartilage, and therefore belonged to the category of resection, a much less serious operation.

¹ Schüller, *Die Tracheotomie, Laryngotomie, und Extirpation des Kehlkopfes*, S. 197. Stuttgart, 1880.

² *Ibid.*

³ Pitha und Billroth's *Deutsche Chirurgie*. Bd. iii. Abth. 1, Lief. 5 (Tracheotomie und Laryngotomie), S. 99.

⁴ Bergen, *Revue des Sciences Médicales*, t. ix. p. 298; *Am. Jour. Med. Sci.*, Jan. 1878, p. 268.

⁵ Foulis, *Trans. International Med. Congress*, vol. iii. page 255. London, 1881.

⁶ *Versuche über Kehlkopf-extirpation* (*Wiener med. Woch.*, S. 559. 1871).

⁷ Gussenbauer, *Arch. f. klin. Chir.*, Bd. xvii. S. 343. 1874.

⁸ Gussenbauer, cited by Schüller (*op. cit.*, S. 198).

⁹ *Brit. Med. Jour.*, July 21, 1883, p. 115.

¹⁰ *Trans. Internat. Med. Congress*, vol. iii. p. 258. London, 1881.

TABLE OF COMPLETE LARYNGECTOMIES, INCLUDING AND SUPPLEMENTING THE TABLES OF MACKENZIE, FOULIS, BLUM, AND BUROW.

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
1	Watson, Patrick Heron (Edinburgh).	1866	36	M.	Stenosis from syphilis.	Larynx and one ring of trachea.	Death in 3 weeks from pneumonia.	Foulis: Transactions International Med. Congress, vol. iii. p. 255, 1881.	Pneumonia was suspected before the operation.
2	Billroth (Vienna).	1873 Dec. 31	36	M.	Carcinoma of the larynx.	Larynx, lower third of upper two rings of trachea.	Death from recurrence 7 months after the operation.	Archiv f. klin. Chirurgie, Bd. xvii. S. 343.	Recurrence noted at end of 4 months.
3	Heine (Prague).	1874 April 28	50	M.	Carcinoma of the larynx.	Entire larynx.	Death from recurrence 6 months after operation.	Arch. f. klin. Chir., Bd. xix. S. 584; Böhm. Correspond. Bl., 1874.	
4	Schmidt, M. (Frankfort).	1874 Aug. 12	56	M.	Epithelioma of the larynx.	Thyroid, cricoid, and both arytenoid cartilages.	Death on the fourth day from collapse.	Arch. f. klin. Chir., Bd. xviii. S. 189.	
5	Maas (Breslau).	1874 June 1	57	M.	"Adeno-fibroma carcinomatosum."	Entire larynx.	Death from pneumonia 2 weeks after operation. "On fourth day." (Blum.)	Arch. f. klin. Chir., Bd. xix. S. 507.	
6	Watson, P. H. (Edinburgh).	1874	60	M.	Epithelioma of larynx extending to left vocal band.	Larynx.	Death from pneumonia in 2 weeks.	Foulis, Trans. Inter. Med. Congress, 1881.	
7	Schönborn (Königsberg).	1875 Jan. 22	72	M.	Carcinoma of the larynx.	Entire larynx.	Death on the fourth day.	Berliner klin. Woeh., 20 Sept. 1875, S. 525.	The operation ended with copious hemorrhage, and was followed by severe erysipelas.
8	Rottini (Turin).	1875 Feb. 6	24	M.	Sarcoma (partly round-celled, partly spindle-celled) of the larynx.	Entire larynx.	WELL, Oct. 7, 1884, NEARLY TEN YEARS AFTER OPERATION.	Comunicazione letta innanzi la R. Accademia di Medicina di Torino, 30 Aprile, 1875. Letter from Prof. F. Massei.	
9	Langenbeck (Berlin).	1875 July 21	57	M.	Carcinoma of upper part of larynx, of the epiglottis, and of the hyoid bone.	Entire larynx, hyoid bone, part of the tongue, pharynx, and œsophagus.	Death from recurrence in cervical lymphatic glands, four months after.	Berlin. klin. Woeh., 1875, No. 33, S. 453; Arch. f. klin. Chir., Bd. xxi. Supplement, S. 136.	
10	Miltanowski (St. Petersburg).	1875 July 27	59	M.	Carcinoma.	Entire larynx.	Death from croupous pneumonia 3 months after operation.	Centbl. f. Chir., 1882, No. 25; and letter from Dr. A. Schmidt to Prof. Burrow (Archives of Laryngology, April, 1883).	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
11	Multanowski (St. Petersburg).	1875 Aug. 9	47	M.	Carcinoma.	Entire larynx.	Death from recurrence 2 months after opera- tion.	Ibid.	
12	Billroth (Vienna).	1875 Nov. 11	54	M.	Diffuse carcinoma of the larynx.	Entire larynx.	Death on the fourth day from extensive broncho-pneumonia.	Billroth, Clinical Surgery, p. 133. London, 1881.	Had not been pre- ceded by tracheot- omy; wound did well, with but little febrile reaction.
13	Maas (Freiburg).	1876 Feb. 5	50	M.	Epithelioma of the larynx.	Entire larynx, with exception of the epi- glottis and of a small piece of the cricoid cartilage.	Death from recurrence 6 months after the operation.	Arch. f. klin. Chir., Bd. xx. S. 535. Private com- munication from operator to Dr. Foulis (Trans. Int. Med. Cong., 1881).	Recurrence in poste- rior portion of tongue about three months after ope- ration. Death by hemorrhage from the ulcerated mass.
14	Gerdes (Jever).	1876 Mar. 30	76	M.	Carcinoma.	Entire larynx.	Death on the fourth day from collapse.	Arch. f. klin. Chir., Bd. xxi. S. 473.	
15	Reyher (Dorpat).	1876 May	60	M.	Carcinoma of the vo- cal bands.	Entire larynx, with ex- ception of epiglottis.	Death on the eleventh day from hypostatic pneumonia.	St. Petersburg med. Woeh., Nos. 17 and 18, 1877.	
16	Watson, P. H. (Edinburgh).	1876	60	F.	Epithelioma of lar- ynx, with enlarge- ment of some ad- jacent glands.	Larynx and enlarged glands.	Death in one week from pulmonary em- bolism.	Letter from operator to Dr. Foulis.	The lingual and fa- cial veins were cut in the operation.
17	Kosinski (Warsaw).	1877 Mar. 15	36	F.	Epithelioma of the larynx, with per- foration of the skin.	Entire larynx.	Death from recurrence 9 months after opera- tion.	Centbl. f. Chir., No. xxvi. 1877, S. 401. Private communication from ope- rator to Dr. Foulis.	
18	Foulis (Glasgow).	1877 Sept. 10	28	M.	Sarcoma; "partly papilloma, partly spindle-celled sar- coma."	Entire larynx, with exception of superior cornua of thyroid car- tilage and half the arytenoid cartilages.	Death from tracheal and pulmonary phthisis, March 1, 1879.	Lancet, Oct. 13, 1877, and March 29, 1879.	
19	Wegner (Berlin).	1877 Sept. 16	52	F.	Carcinoma of the lar- ynx, size of walnut, originating from right ventricle.	Entire larynx, with epiglottis, but leav- ing lower half of the cricoid cartilage.	WELL, APRIL 12, 1878.	Verh. der Deut. Gesellsch. f. Chir., 1878. Private communication from ope- rator to Dr. Foulis.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
20	Bottini (Turin).	1877 Aug. 29	48	M.	Epithelioma of the larynx.	Entire larynx and por- tion of œsophagus.	Death on the third day from double pneu- monia.	Annales des Maladies de l'Oreille et du Larynx, 1 Juillet, 1878; Centbl. f. Chir., 1878.	Performed "blood- lessly" with galva- no-cautery blade.
21	Bruns, Victor von (Tübingen).	1878 Jan. 29	54	M.	Epithelioma of the larynx (of 5 years' duration).	Entire larynx.	Death from recurrence 9 months after opera- tion.	Wien. med. Presse, 17 Nov. 1878. Communication from Prof. Paul Bruns to Dr. Foulis.	Preliminary trache- otomy not perform- ed. Collapse after operation, and hy- perpyrexia for a week. Voice-tube employed in five weeks.
22	Rubio (Madrid).	1878 May 11	41	M.	Perichondritis of the thyroid cartilage, with necrosis.	Entire larynx.	Death on the fifth day from marasmus.	Observación clinica, etc., Real Academia de Med., Madrid, 1878.	
23	Czerny (Hildelberg).	1878 Aug. 24	46	M.	Lympho-sarcoma in and under vocal bands, and perfor- ating the thyroid cartilage; also in- volving the neigh- boring glands.	Entire larynx, and the diseased glands.	Death from recurrence 15 months after ope- ration (in high fever with right-sided pleurisy), Nov. 30, 1879.	Letter from operator to Dr. Foulis. Schüller, Die Tra- cheotomie (Billroth und Lücke's Deutsche Chirurgie, H. 37, S. 200). Berlin. Klin. Woch., No. 26, 1882. Reprint (Maurer).	Repeated removals of recurring masses (5 operations). Sup- puration of exten- sive glandular me- tastases. Resection of common jugular vein, of common, internal, and ex- ternal carotid arte- ries, and of pneu- mogastric nerve. Paralysis. Ex- tremely wretched condition of pa- tient.
24	Billroth (Vienna).	1879 Feb. 27	43	F.	Epithelioma of phar- ynx, larynx, and thyroid gland.	Entire larynx, with part of pharynx and œsophagus.	Death during seventh week from passage of bougie into medias- tinum.	Private communication from operator to Dr. Foulis.	
25	Gussenbauer, (Prague).	1879 May 24	24	M.	Tuberculous tumor supposed to have been carcinoma.	Entire larynx.	Death 2 months after operation, from tuber- culosis pulmonum.	Centralbl. f. Chir., No. 45, 1882.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
26	Macewen, Wm. (Glasgow).	1879 July 31	56	M.	Carcinoma of larynx and upper end of gullet; also a glandular mass at left side of neck.	Larynx, part of gullet, and the glandular mass.	Death in 3 days from pneumonia.	Foullis, Trans. Int. Med. Congress, 1881.	
27	Caselli, Azzio (Reggio-Emilia).	1879 Sept. 20	19	F.	Sarcoma of larynx, pharynx, palate, and base of tongue.	Entire larynx, phar- ynx, base of tongue, soft palate, and ton- sils.	WELL, August, 1881 (probably still liv- ing).	Bul. del Scien. Med. Bolog- na, tomo v. 1880. Centbl. f. Chir., 1880; Caselli's Reprint, Bologna, 1880. Caselli's statement at meeting Int. Med. Cong., London, 1881.	Operation occupied more than 3 hours, was largely done with the galvano- caustic blade, and was attended with but little hemor- [rhage.
28	Lange, F. (New York).	1879 Oct. 12	74	M.	Sarcoma of larynx involving the gul- let.	Larynx, right cornu of hyoid bone, part of gullet.	Death from asthenia nearly seven months after operation. Re- currence.	Archives of Laryngology, N. Y., 1879, p. 36.	
29	Multanowski (St. Petersburg).	1879 Dec. 4	60	M.	Carcinoma.	Entire larynx.	Death on fifth day from pneumonia.	Centralbl. f. Chir., No. 25, 1882. Letter from Dr. A. Schmidt to Prof. Burow (Arch. Lar., April, 1883).	
30	Langenbueh.	1879	An aged female		Carcinoma.	.....	Death on third day from collapse.	Verh. der Deutsche Ges. f. Chir., Bd. x.	Only found in Blum's list (Arch. Gén. de Méd., tome ii. 1882, p. 79).
31	Reyher, Carl (St. Petersburg).	1880	48	M.	Carcinoma.	Larynx.	Death on seventh day from septic broncho- pneumonia.	Wolner's Med. Jour., 1880, H. 1. Letter from operator to Dr. Konlis.	Tracheotomy, Sept. 27, 1879. Laryng- otomy for access to growths, Feb. 3, 1880. Recurrence
32	Thiersch (Leipsie).	1880 Feb. 26	36	M.	Carcinoma.	Entire larynx and two rings of trachea.	Death, Aug. 19, 1882, eight days after a se- cond operation ne- cessitated by recur- rence. Duration of life after extirpation of larynx, TWO AND A HALF YEARS.	f. med. Wiss., 23 Sept. 1882. Revue Mens. de Laryn., No. 82, p. 350, but accredited to Landerer. Letter from operator to compiler, Nov. 8, 1883.	first noted early in '82. Arterial bleed- ing; ligature of ea- rotid; new bleed- ing; trial made of extirpation. Dif- fuse carcinoma to below the sternum.

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
33	Thiersch (Leipsic).	1880 April 15	52	M.	Carcinoma.	Entire larynx.	ALIVE AND WELL, NOV. 8, 1883, THREE YEARS AND SEVEN MONTHS AFTER OPERATION. Death in 1883, from general tuberculosis. Recurrence in four months. Excision of right lobe of thyroid gland and part of pharynx (Jan. 14, 1881). Death from hemorrhage on 11th day.	Ibid.	Tracheotomy, Mar. 2, 1880.
34	Kocher (Berne).	1880 July	...	...	Lupus.	.....		Letter from operator Sept. 24, 1883.	Low tracheotomy, July 14, 1880.
35	Novaro	1880 Aug. 19	63	M.	Carcinoma.	Entire larynx.	Recurrence in four months. Excision of right lobe of thyroid gland and part of pharynx (Jan. 14, 1881). Death from hemorrhage on 11th day.	Giorri. di R. Acad. di med. di Torino, tomo xxix. p. 34, 1881. Arch. Ital. di Lar., Anno I., p. 75, 1881-1882.	
36	Czerny (Heidelberg).	1880 Oct. 11	47	M.	Epithelioma of larynx and suprajacent soft parts.	Larynx and soft tissues in front of it.	Death from exhaustion and severe hemorrhage 5 months (Mar. 25, 1881) after.	Letter from operator to Dr. Fonlis. Berl. klin. Woch., No. 26, 1882. Reprint (Maurer).	Extensive recurrence in throat.
37	Hahn (Berlin).	1880 Oct. 23	67	M.	Carcinoma.	Larynx, all except a portion of the thyroid cartilage.	FREE FROM RECURRENCE 2 YEARS AFTER OPERATION.	Letter from operator to Prof. Burow (Archives of Laryngology, April, 1883).	Possibly Case 5 of table on p. 768.
38	Thiersch (Leipsic).	1880 Nov. 10	45	F.	Carcinoma of pharynx and larynx.	Larynx and part of pharynx.	Death from recurrence in 4 months (March 16, 1881).	Deutsch. Zisch. f. Chir., Bd. xvi. S. 149. 1881.	Tracheotomy, Oct. 17, 1880. Recurrence noted within six weeks after operation.
39	Bircher, H. (Aarau).	1880 Dec. 3	49	F.	Scirrhus of the thyroid gland, involving the larynx.	Thyroid gland excised; 6 months after, the cancer recurred, and the larynx was excised with part of the gullet.	Death in 16 days from pneumonia and gangrene of the lung.	Letter from operator to Dr. Fonlis (Trans. Int. Med. Congress, 1881).	
40	Pick (London).	1881 Jan. 16	39	M.	Epithelioma of larynx (preceded by papillomata).	Larynx and epiglottis.	Death in 5 days from pleurisy and pericarditis.	Lancet, April 2, 1881, p. 541. Brit. Med. Journ., April 9, 1881, p. 562.	
41	Thiersch (Leipsic).	1881 Jan. 17	57	F.	Carcinoma of pharynx and larynx.	Entire larynx and part of pharynx.	Death on seventh day from secondary infectious pneumonia.	Deutsch. Zisch. f. Chir., Bd. xvi. S. 149. 1881.	Tracheotomy, Dec. 9, 1880.

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
42	Toro (Cadiz).	1881 March 9	...	...	Epithelioma of larynx.	Hyoid bone, base of tongue, and larynx.	Death on fourth day from pulmonary emphysema.	Med. Record, Aug. 6, 1881, p. 167.	
43	Winiwarter, (Liège).	1881 April	55	F.	Carcinoma.	Entire larynx.	ALIVE AND WELL, JULY 1884, THREE YEARS AND FOUR MONTHS AFTER OPERATION.	Clinique Chir. Univ. Liège. Monatschr. f. Ohrenheilk. No. 9, 1882. Burow's list. Letter from operator to compiler, Oct. 7, 1884.	
44	Foulis (Glasgow).	1881 April 30	50	M.	Epithelioma of larynx (preceded by papillomata).	Larynx.	WELL AND STRONG, Aug. 1881.	Brit. Med. Journ., May 7 and June 11, 1881: Trans. Int. Med. Cong., 1881.	
45	Czerny (Heidelberg).	1881 May 12	47	M.	Epithelioma.	Larynx and upper two rings of trachea.	Death from recurrence 18 months after operation (Nov. 1882).	Letter from operator to Dr. Foulis. Verbal report to Int. Med. Cong., London, 1881. Letter from operator to compiler.	
46	Reyher, Carl (St. Petersburg).	1881 May 14	57	M.	Carcinoma.	Larynx.	Death on fifth day from septic broncho-pneumonia.	Letter from operator to Dr. Foulis (Trans. Int. Med. Congress, 1881).	
47	Kocher (Berne).	1881 May 16	59	M.	Carcinoma.	Entire larynx, except a piece of the cricoid cartilage.	Death in 1883, say two YEARS AFTER OPERATION, from cancerous disease of abdomen. No LOCAL RECURRENCE.	Letter from operator to Prof. Burow (Arch. Laryu., N. Y., April, 1883). Letter from operator to compiler, Sept. 1883.	Patient wears a self-made artificial epiglottis to overcome choking in deglutition, result of excision of epiglottis.
48	Tilanus (Amsterdam).	1881 May	51	M.	Epithelioma.	Entire larynx.	Death in 36 hours from collapse.	Centbl. f. Chir., No. 34, 1882.	
49	Gussenbauer (Prague).	1881 May 19	48	M.	Carcinoma.	Entire larynx.	WELL, MORE THAN 2 YEARS AFTER OPERATION. Doing duty as a riding master.	Letter from operator to Prof. Burow (Arch. Laryu., N. Y., April, 1883). Prag. med. Woch., No. 31, 1883.	
50	Volker (Brunswick).	1881 May 28	44	F.	Carcinoma epithelioides.	Entire larynx.	Death from suffocation 5 months after operation.	Academisch Proefschrift, S. 84 und 112. Amsterdam, 1882.	Suffocated while patient had with-drawn canula to cleanse it.

TABLE OF COMPLETE LARYNGECTOMIES.—Continued.

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
51	Albert (Vienna).	1881 July 6	45	M.	Carcinoma, almost filling right half of larynx.	Entire larynx, except epiglottis; also small section of adherent oesophagus.	Death on eighth day from diffuse bronchitis and lobular pneumonia.	Wien med. Presse, Bd. xxii. S. 1373. 1881.	On 13th, hemorrhage from internal carotid, arrested by ligature above and below point of erosion. Collapse same evening; death next day.
52	Hahn (Berlin).	1881 Aug. 13	46	M.	Carcinoma.	Entire larynx.	Death in 25 days from putrid bronchitis.	Letter from operator to Prof. Burow.	
53	Margary (Turin).	1881 Sept. 29	36	F.	Epithelioma of oesophagus and larynx.	Larynx, first ring of trachea, thyroid body, part of pharynx, and oesophagus. Entire larynx.	Death by hemorrhage, March 25, 1882.	Arch. Ital. di Lar., 1881—1882, pp. 121, 172.	Recurrence at end of three months.
54	Gussenbauer (Prague).	1881 Oct.	62	M.	Carcinoma.	Entire larynx.	STRONG AND WELL 21 MONTHS AFTER OPERATION.	Prag. med. Woch., No. 31, 1883.	
55	Reyher, Carl (St. Petersburg).	1881 Oct. 10	73	M.	Carcinoma.	Larynx and upper three rings of trachea.	Death from recurrence 9 months after operation.	St. Petersburg. med. Ztschr., No. 28, 1882. Letter from operator to Prof. Burow.	
56	Reyher, Carl (St. Petersburg).	1881 Oct. 10	65	M.	Carcinoma.	Larynx.	Death on seventh day from septic pneumonia.	Ibid.	
57	Schede, M. (Hamburg).	1881 Nov. 4	54	M.	Canceroid.	Larynx, hyoid bone, and thyroid gland.	Recurrence 6 mos. after operation, too extensive for extirpation. Date of death not mentioned.	Deutsche med. Woch., No. 33, 1882, S. 45. Letter from operator, Sept. 1884.	
58	Reyher, Carl (St. Petersburg).	1882 April 7	55	M.	Carcinoma epithelioides.	Entire larynx, pharynx, and parts of oesophagus.	Death 14 days after operation from exhaustion.	Letter from operator to Prof. Burow.	
59	Kocher (Berne).	1882 May 13	54	M.	Carcinoma.	Entire larynx and carotid glands.	Recurrence in lymphatic glands 7 months after operation. STILL LIVING WITHOUT LOCAL RECURRENCE, Sept. 24, 1883, 16 MONTHS AFTER OPERATION.	Letter from operator to Prof. Burow. Letter from operator to compiler.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
60	Whitehead, Wm. (Manchester).	1882 May 27	46	M.	Epithelioma of right vocal band and parts subjacent, as far down as upper portion of trachea. Carcinoma. (Adeno- sarcoma?)	Thyroid and cricoid cartilages and two rings of trachea, leav- ing epiglottis intact.	WELL, January 31, 1883. Probably still alive.	Lancet, Nov. 4, 1882, p. 741. Letter from operator to compiler, dated Jan. 31, 1883.	
61	Von Bergmann (Würzburg).	1882 June 12	54	M.	Carcinoma. (Adeno- sarcoma?)	Entire larynx.	Recurrence, Feb. 1883; death (Zesas).	Sitzungsber. Würzburg Phys. Gesell., S. 47-56, 1882. Deutsche med. Woeh., No. 35, 1882. Centbl. f. Chir., 19 Aug. 1882. Archives of Laryngology, April, 1883.	
62	Burow (Königsberg).	1882 July 7	44	M.	Carcinoma.	Entire larynx without epiglottis.	Death from sudden suffocation 4½ months after operation.	Volkmann, Samml. klin. Vorträge, No. 224, S. 1944. Letter from operator, Sept. 24, 1883.	
63	Kocher (Berne).	1882 Sept. 28	43	M.	Carcinoma.	Entire larynx and a portion of œsophagus	ALIVE AT LAST ACCOUNT.	Wiener med. Presse, Bd. xxiii. S. 1672. Wien. med. Woeh., No. 44, 1882. Wien. med. Presse, Bd. xxv. S. 367. 1884.	
64	Maydl (Vienna).	1882 Aug. 31	50	M.	Carcinoma.	Larynx, except cricoid cartilage. Excision of a gland, size of a dove's egg.	ALIVE AND WELL, 16 mos. AFTER OPERA- TION.	Centbl. f. Chir., No. 45, 1882. Raccoglitore Med., t. xviii. p. 36. 1882. Letter from Prof. F. Massei. Ind. Med. Gaz., vol. xviii. pp. 24-26, 1883. Lancet, Sept. 15, 1883. Jour. Am. Med. Assoc., Oct. 27, 1883, p. 487.	"Recovery in 28 days." (Burow's list.)
65	Ruggi.	1882	10	M.	Papilloma of larynx.	Entire larynx.	ALIVE, Oct. 7, 1884.		Autopsy showed mi- liary tubercles in both lungs, small vomicæ in right lung; a pint of fluid in the left pleura.
66	McLeod (Calcutta).	1882 Nov. 15	35	M.	Papilloma of larynx. (Tubercular?)	Entire larynx and thy- roid gland.	Death at 5½ months.		The growth sprang from the interior of the larynx.
67	Hodgen (St. Louis).	.....	...	...	.....	.....	Death in 4 days.	Letter from Dr. W. C. Glas- gow, St. Louis.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No	Operator.	Date.	Age	Sex	Disease.	Parts removed	Result.	Reference.	Remarks
68	V. Holmer (Copenhagen).	1882 Mar. 15	57	...	Epithelioma.	Larynx, except epi- glottis.	Death in 7 months from recurrence.	Reprint from Hospitals-Ti- deude, Copenhagen, 1883.	
69	V. Holmer (Copenhagen).	1882 July 18	63	M.	Epithelioma	Larynx, epiglottis, and part of pharynx.	Death in 4 months from recurrence.	Reprint from Hospitals-Ti- deude, Copenhagen, 1883.	
70	Maydl, Karl (Vienna).	1883 Mar. 27	45	M.	Carcinoma.	Entire larynx and up- per part of trachea.	Death 5th day. Severe arterial hemorrhage.	Wien. med. Presse, 24 März, 1884, S. 364.	Tracheotomy proved insufficient to avert impending death on account of rapid extension of dis- ease. The autopsy showed extensive degenerative les- ions, which might have caused death independently of the operation. A large part of the operation was done with the thermo- cautery, a possible factor in the secon- dary hemorrhages. Unpublished.
71	Kocher (Berne).	.....	...	...	Carcinoma?	.....	PATIENT ALIVE, with glandular involve- ment without local recurrence, Sept. 24, 1883, SEVERAL MONTHS AFTER OPERATION.	Letter from operator to com- piler.	
72	Winiwarter.	1882 Sept.	46	M.	Carcinoma.	Entire larynx except cricoid cartilage. Several lymphatic glands.	Recurrence April, 1883, seven months after operation.	Letter from operator to com- piler, Oct. 7, 1884.	Unpublished.
73	Winiwarter.	1883 Oct.	50	M.	Carcinoma.	Entire larynx, part of pharynx, several lymphatic glands. Resection of internal jugular vein.	Death in ninth week from inanition; the wound perfectly gra- nululated.	Ibid.	Unpublished.

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
74	Preetorius, A.	1883 July 28	54	F.	Carcinoma.	Larynx, except lower half of cricoid cartilage. Two enlarged glands. Entire larynx.	No RECURRENCE, Nov. 1883.	Deutsche Zeitsch. f. Chir., Bd. xix. S. 621. Centbl. f. Chir., 21 Juni, 1884.	Preliminary tracheotomy 14 days before operation.
75	Leisrink, H.	1883 Aug.	72	M.	Carcinoma.	Entire larynx.	Death in 4 months from croupous pneumonia.	Berlin. klin. Wochensch., 4 Feb. 1884.	Preliminary tracheotomy.
76	McLeod (Calcutta).	1883 Sept. 19	54	M.	Carcinoma?	Entire larynx with tumor of pharynx and right lobe of thyroid gland; indurated lymphatic glands.	Death on fifth day from secondary hemorrhage.	Lancet, April 26, 1884, p. 750.	Microscopic report suggests sarcoma. Embryonic tissue; fusiform and polynucleated cells.
77	Novaro.	1883 Oct. 1	54	M.	Carcinoma originating in right pyriform sinus.	Entire larynx, thyroid body, and part of the wall of the pharynx.	Death in 1 month from croupous pneumonia.	Gaz. deg. Osp., 9 Dec. 1883; Letter from Prof. F. Massie.	No preliminary tracheotomy. Trendelenburg's canula not employed.
78	Jones, Thos. (Manchester).	1884 April 26	44	M.	Carcinoma.	Entire larynx, first ring of trachea, anterior and lateral walls of pharynx.	Well, June 14, 1884, one and a half mos. after operation.	Lancet, Aug. 2, 1884, p. 191; Med. News, Aug. 23, 1884, p. 21.	
79	Hahn, E. (Berlin).	?	43	..	Carcinoma.	Larynx, part of oesophagus, and neighboring glands.	Death in 4th week from suppurative bronchitis and pneumonia.	Beilage zum Centralblatt für Chirurgie, 1884, No. 23, S. 54.	Possibly same case as No. 52.
80	Hahn, E.	?	48	..	Carcinoma.	Larynx, part of oesophagus, and neighboring glands.	Death in 5th week from suppurative bronchitis and pneumonia.	Ibid.	
81	Hahn, E.	1884 Jan.	58	..	Carcinoma.	Entire larynx.	Living three months after operation.	Ibid.	
82	Schede (Hamburg).	1884	69	M.	.....	.....	.....	Letter from operator Sept. 18, 1884.	Prognostics very favorable.
83	Schede.	1884	58	F.	.....	.....	.....	Ibid.	
84	Durante (Rome).	1884?	..		Carcinoma. "Epithelioma."	.....	Death in two or three days.	Letter from Prof. F. Massei, of Naples, Sept. 10, 1884.	Communicated to the Medical Society of Rome.

¹ As the particulars of cases numbered higher than 84 were not received until the others were in type, the chronological order is not preserved. I desire to express my thanks to Mr. Whitehead, and to Profs. Czerny, Gussenbauer, Holmer, Kocher, Massei, Schede, Thiersch, and Winwarter for their kind letters.

TABLE OF COMPLETE LARYNGECTOMIES.—*Concluded.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
85	Novaro.	1882 Jan.	68	M.	Carcinoma.	Entire larynx and upper rings of trachea.	Sudden death March 8, 1883. No recurrence.	Letter from Prof. Massel, Oct. 7, 1884.	Crico-tracheotomy in haste Sept. 12, 1881; thyrotomy and removal by scraping Dec. 30, 1881.
86	Novaro.	1882 July 26	52	M.	Carcinoma.	Entire larynx.	ALIVE WITHOUT TRACE OF RECURRENCE OCT. 7, 1884, NEARLY 2 YEARS AND 3 MONTHS AFTER OPERATION.	Ibid.	Tracheotomy in haste April 19, 1882. A nodule the size of a walnut removed Nov. 8, 1882.
87	Novaro.	1882 Aug. 18	72	M.	Carcinoma.	Entire larynx.	Sudden death by suffocation April 19, 1883. Pen(quill?) found in trachea. It had been used for cleaning tube. No trace of recurrence.	Ibid.	Low tracheotomy June 11, 1882.
88	Gussenbauer.	1883 Feb. 6	63	M.	Carcinoma.	The cartilages and their museles; the epiglottis, with the mucous membrane at the top of the larynx in connection with the aryteno-epiglottic folds, being retained.	Well six months after operation.	Prager med. Woch., No. 31, 1883.	To try and avoid laryngectomy, tracheotomy had been performed the day before, and had been immediately followed by thyrotomy.
89	Bergmann (Berlin).	1883	...	M.	Carcinoma.	.....	Death from pneumonia four days after operation.	Zesas, Arch. f. klin. Chir., Bd. xxx. H. 3, S. 672. 1884.	
90	Vogt (Greifswald).	1884 Feb.	29	F.	Carcinoma.	.....	Death from exhaustion seven days after operation.	Mittheilungen aus der chir. Klinik zu Greifswald. Cited by Zesas (loc. cit.).	
91	Holmes (London).	1884 May 26	63		Epithelioma.	Entire larynx except left half of cricoid cartilage. Free resection of pharynx.	Death from collapse in forty hours.	British Med. Journ., Oct. 25, 1884, p. 809.	A mass outside the larynx, reaching to the tonsil, could not be fully removed.

TABLE OF UNILATERAL LARYNGECTOMIES.

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
1	Billroth (Vienna).	1878 July 7	50	M.	Unilateral carcinoma from left vocal band to cricoid cartilage.	Left half of larynx and portion of right vocal band.	Alive June 23, 1879, but disease had commenced at six months in the cervical glands, with subsequent local recurrence.	Mackenzie, op. cit., vol. i. p. 348; Schüller, op. cit., S. 199, 211.	The patient was able to speak, without artificial aid, in a dull but distinct voice, and was able to take part in committee work.
2	Gerster (New York).	1880 Mar. 5	50	M.	Sarcoma of right part of pharynx, larynx, and base of tongue.	Right half of hyoid bone, larynx, and pharynx; right tonsil, epiglottis, and part of base of tongue.	Death from pleurisy, Mar. 9, 1881, one year after operation. No recurrence.	Archives of Laryngology, vol. i. p. 124. 1880. Letter from operator to Dr. Foulis. Foulis's list.	
3	Reyher, Carl (St. Petersburg).	1880 Mar. 9	57	M.	Carcinoma.	Left half of larynx.	No RECURRENCE FOURTEEN MONTHS after operation.	Letter from operator to Dr. Foulis. Foulis's list.	
4	Caselli.	1880 Nov. 9	7	M.	Enchondroma of neck.	A large tumor of thyroid cartilage.	Death in two days.	Pamphlet by Dr. Caselli. Foulis's list.	
5	Hahn (Berlin).	1880	67	...	Carcinoma.	Half of larynx.	PATIENT LIVING THREE AND A HALF YEARS AFTER OPERATION; NO RECURRENCE.	Beilage zum Centralbl. f. Chir. No. 23, 1884, S. 55. Lond. Med. Record, Aug. 15, 1884. Ibid.	Probably the same case as No. 37 in table of complete laryngectomies.
6	Schede (Hamburg).	1882 Oct. 19	...	M.	Infiltrating carcinoma.	Right half of larynx; epiglottis not included.	PATIENT LIVING EIGHTEEN MONTHS AFTER OPERATION.		Patient (a dentist) speaks so well without apparatus that his patients do not notice his defect. A cicatricial fold does duty for the lost vocal band.
7	Hahn.	1883	54	...	Carcinoma.	Half of larynx.	PATIENT LIVING NINE MONTHS AFTER OPERATION; NO RECURRENCE.	Ibid.	

TABLE OF UNILATERAL LARYNGECTOMIES.—*Concluded.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
8	Wagner, Clinton (New York).	1883 Feb. 22	53	M.	Epithelioma (in recurrence).	Right half of larynx and right half of first ring of trachea.	Death from collapse on twelfth day.	Archives of Laryngology, p. 130. 1883.	The growth appeared first as a papilloma (microscopical examination). Two thyrotomies were performed. See Arch. Lar., p. 51. 1883; Medical News, Feb. 3, 1883.
9	Winiwarter (Liège).	1883 Dec.	18	M.	Perichondritis with marked stenosis.	Right half of larynx, leaving the mucous membrane.	PATIENT LIVING TEN MONTHS AFTER THE OPERATION.	Letter from operator, Oct. 7, 1884.	Patient speaks without apparatus in a hoarse voice, audible in a large room.
10	Küster.	?	50?	M.	Sarcoma of one vocal band.	One side of the larynx.	Recovery.	Beilage zum Centralbl. f. Chir. No. 23, 1884, S. 57.	Repeated endolaryngeal operations; vocal band excised; rapid recurrence; then the excision of one-half of the larynx.
11	Id.	?	?	?	?	do.	do.	Ibid.	Operator mentions that he has had these three cases, without giving details.
12	Id.	?	?	?	?	do.	do.	Ibid.	
13	Id.	?	?	?	?	do.	Death.	Ibid.	

From the records referred to in the first of the above tables, and from study of some of the reports in detail, it appears evident that complete laryngectomy can be performed without sacrifice of life, but that every operation places life in peril; and that a large number of the patients succumb within a period so brief, that their early death is attributable to the operation and to nothing else. Of the deaths reported, 26 occurred within the first eight days, and 5 more within the second eight days—more than one-third of all the patients subjected to laryngectomy having thus succumbed within little more than a fortnight.

Death within the first few days occurs from shock, from hemorrhage, or from pneumonia. Very few have succumbed to shock, and only two to hemorrhage; but very many have perished from pneumonia. The occurrence of pneumonia is largely attributed to the escape of food, blood, and morbid products into the air-passages, although every available precaution has been taken to prevent this by firmly tamponing the wound with antiseptic plugs. If an inference may be suggested from what I have observed in various other operations upon the neck, it is that surgical interference of any kind in the cervical region entails a risk of pneumonia, even though the air-passage be not opened. I have seen it follow extirpation of the thyroid gland, extirpation of neoplasms, and even mere exploratory incision. The reduction of temperature to which the pneumogastric nerve is subjected, may lead to pneumonia, especially when it has been rendered additionally sensitive by manipulations within the wound. Some laryngectomies have consumed from one to three hours in their performance—an ordeal to the pneumogastric nerve quite sufficient, to my mind, to account for an early pneumonia, independently of direct sepsis.

The period of danger from pneumonia does not seem to exceed two weeks, unless the conditions are exceptional. This important fortnight of tribulation safely bridged, the life of the patient may be regarded as tolerably secure up to the fourth month. Then death from recurrence begins to be imminent, and, according to circumstances, will take place within an additional period varying from a few weeks to several months, or to more than a year.

Complete laryngectomy involves great risk of death by pneumonia, future respiration through an artificial aperture, temporary nourishment by the stomach-tube, and possibly utter inability to speak without the aid of an artificial substitute for the larynx, adjusted to the tracheal canula.

Unilateral laryngectomy does not necessarily involve dependence upon any of these mechanical aids.

INDICATIONS FOR THE OPERATION.—As will be seen from the preceding tables, of some ninety complete exsections of the larynx, seventy-eight or eighty have been performed for carcinoma,¹ four for sarcoma, one for lympho-sarcoma, two for papillomata, one for lupus, one for perichondritis, and one for cicatricial syphilitic stenosis. Of the thirteen unilateral exsections, six have been performed for carcinoma, two for sarcoma, and one each for perichondritis and for enchondroma of the neck. The disease in the remaining three has not yet been recorded.

It would be desirable to select for special consideration the operations upon carcinomas strictly intrinsic, and contrast the final results with the final results in similar cases let alone or subjected to palliative tracheotomy; and to make a similar study of the comparative results in carcinomas which have involved adjacent structures and lymphatic glands. Prof. Czerny writes me

¹ Included among these are the cases in which the histology of the tumor was doubtful, since the operations were undertaken under the opinion that the disease was carcinomatous.

that the condition of some of his tracheotomized patients, in hopeless cases, was much more deplorable than the condition of those subjected to laryngectomy, who were, at least, entirely free from pain. It is likewise contended by some observers that, as tracheotomy does not relieve the dysphagia, this symptom is an additional reason for preferring the risks of laryngectomy.

It is hard to comprehend the necessity for sacrificing the whole of the larynx in cases of polypi or of papillomata, however extensive, or in cases of perichondritis and of cicatricial stenosis, whether syphilitic or otherwise, diseases for the treatment of which surgery offers resources less extreme.

It seems to me that the indication for complete laryngectomy should be restricted to sarcoma, to intrinsic carcinoma, and possibly to circumscribed extrinsic carcinoma, which has not extended to adjacent structures or involved the lymphatic glands. In diffuse carcinoma extending beyond the larynx, it seems to be contra-indicated. Laryngeal carcinoma is often so long strictly intrinsic, and extrinsic carcinoma often so long unassociated with lymphatic involvement, that early operation certainly offers considerable hope of its complete removal, the more that recurrence after extirpation of the larynx has been found more frequent in the lymphatic glands than in the tissues from which the excised structures have been severed. But inasmuch as an early laryngectomy may directly rob the patient of an important remnant of life, the responsibility of the surgeon who undertakes the operation is proportionately great.

When the disease is strictly unilateral, the indication is for unilateral laryngectomy—an operation much less serious than excision of the entire larynx, and apparently no more likely to be followed by recurrence, whether in the retained half of the larynx, in adjoining tissues, or in the lymphatic glands.

THE OPERATIVE PROCEDURE.—Undoubtedly always a severe operation, the severity of laryngectomy varies with the physical condition of the patient, the extent of the disease, the circumstances under which the operation is performed, and the complications which may follow. The operation is not necessarily a bloody one. While Bottini¹ has shown that a bloodless operation is practicable with the electric cautery, Langenbeck² has proved that not only may the entire larynx be removed by ordinary surgical methods without much bleeding, provided that the precaution be taken to secure every vessel before it is divided, but, in addition, the submaxillary glands from both sides, the hyoid bone and portions of the tongue, the pharynx, and the œsophagus. Thus, in the instance referred to, forty-one ligatures were employed, securing, among other vessels, both external carotids, the linguals, the external maxillaries, the superior thyroids, and the superior and inferior laryngeals.

Whether the removal of the larynx is to be effected from above downwards, or in the reverse direction, will depend upon the complications of the case, and on the preferences of the surgeon. Removal from above downward is the more tedious. To some operators it appears to be the safer plan, inasmuch as it effectively avoids all risk of escape of blood and other matters into the tracheal extremity of a severed windpipe during the important stages of the dissection; for the severance of the larynx from the trachea is the last step of the procedure instead of the first, and may be delayed until all hemorrhage is under control. The opposite plan is said to possess the advantage, that, the trachea being taken care of in the first instance, the operator can proceed more rapidly, and be relieved from all anxiety as to the entrance of

¹ *Annales des Maladies de l'Oreille, du Larynx, etc.*, 1 Juillet, 1878, p. 182.

² *Berlin. klin. Woch.*, No. 33, 1875, S. 453.

blood into the air-passage. Being without personal experience in the operation, it is impossible for me to do more than express a theoretical preference for the former plan. Splitting the larynx before exsection has been occasionally practised, but does not appear to be in much favor. Another mooted point concerns the disposition to be made of the epiglottis. Independent of any question as to the likelihood of carcinoma recurring in this structure, its retention, according to some operators, does not appear requisite for any purpose. The larynx being removed, the ostensible functions of the epiglottis seem to be better performed by the root of the tongue. A retained epiglottis interferes, too, with the adjustment of an artificial larynx. On the other hand, its retention is said to guard to a certain extent against the descent of food into the air-passage, whether natural or artificial. The weight of testimony seems to indicate the propriety of sacrificing the epiglottis in all cases of carcinoma, and in all others in which an artificial larynx is to be used.

Under special conditions even more tissue may be saved. Thus Gussenbauer,¹ in his fourth case, spared the mucous membrane at the top of the larynx, "in its connection with the ary-epiglottic ligament and the epiglottis," thus limiting the exsection to the cartilages and their muscles. In this way he hoped to prevent descent of the top of the œsophagus. The patient was able to drink his coffee on the third morning without any escape of the liquid externally, and to bear the introduction of an artificial larynx on the fourteenth day.

In the absence of personal observation, the description of the operative procedure here given is only a dead-house and library study, and lacks the precision and confidence of an operator. Yet it may be said that while its principal features are common to all laryngectomies, individualities are presented so frequently as to necessitate departures which are undeterminable beforehand.

When at all practicable, a low tracheotomy should be performed two weeks or longer before the extirpation. Several important objects are accomplished thereby. The patient will have got accustomed to breathing through a mechanical appliance. His general strength will have become invigorated by increased facility in respiration. He can more conveniently and readily be anaesthetized through the artificial opening. The trachea will have become adherent to the integument, and will require no artificial support to prevent its descent when the larynx is severed from it. The lungs having become accustomed to air received through an artificial opening, pneumonia from this source will be less likely to follow.

Gussenbauer, however, does not deem it essential that tracheotomy should long precede the laryngectomy, and considers that a tracheal wound, such as is made in a low tracheotomy, when in the immediate vicinity of a laryngectomy wound, can only be regarded as a complication. Although admitting that this objection does not apply to the wound of a high tracheotomy, which eventually unites with the lower end of the laryngectomy wound, he says that the tissues in the middle line become so infiltrated and so conglomerated that they are less readily recognized, and that their condition may complicate the detachment of the soft tissues and make hemorrhage more serious. He believes that, as the rule, high tracheotomy with horizontal severance of the trachea, as the initial step in the actual laryngectomy, fully suffices to facilitate undisturbed completion of the operation, and to allow secure fixation of the trachea by sutures.

Should the operation be performed without a preliminary tracheotomy some

¹ Loc. cit.

time previous, or immediately preceding, the trachea is usually severed from the larynx as the first step after exposure of the parts by section of the integument, and then a leaden or vulcanite tube (Foulis), a rubber tube (Novaro), or a tampon-canula (von Bruns) sufficiently capacious to make an air-tight fit, is introduced into the trachea.

The patient having been anæsthetized, measures must be taken to prevent escape of blood into the lower air-passages. This may be effected by operating upon the pendent head (Rose's position), or in the same position as modified by Maas, who shoves a footstool under the middle portion of the vertebral column so as to bring the entire field of operation below the level occupied by the canula in the trachea.¹ The same end may be attained by tamponning the trachea, so that the operation may be performed in the usual recumbent position. The air-tampon of Trendelenberg, or some of its modifications, whether with water, air, or sponge, has been used successfully in a number of operations; but, like many other appliances, it is not always continuously reliable. Michael's² modification seems to be the most trustworthy device, as far as I can learn from private inquiries. Michael perforates a cylindrical piece of surgical sponge, lets it imbibe moisture, and then runs the canula through it. The sponge is allowed to dry, and is then surrounded by a water-tight membrane, preferably parchment-foil, which is tied on tightly top and bottom, and covered with a solution of gutta serena. When the canula is in position, the sponge is saturated with water or with an antiseptic solution, by means of a puncture made with a hypodermic syringe. By means of a special attachment, the tissues above the canula can be irrigated during the after-treatment, without removing the tube. The ordinary canula may be wound with sponge, as suggested by Nussbaum and employed successfully by Czerny, Billroth, and Gussenbauer, so that in accordance with the belief of the latter, there seems no absolute occasion for any complicated appliance. Lange³ found tinder to be a much better substance for the purpose than sponge. This seems preferable to the use of either air or water tampons, which are liable to sudden rupture, and may thus unexpectedly complicate the operation. If the larynx be severed from the trachea as the first step of the operation, the trachea is to be tamponed superiorly as far down as the canula, so as to make assurance double-sure. Foulis and Novaro have trusted to air-tight tubes inserted into the top of the severed trachea. Foulis used a curved leaden tube covered with rubber, and Novaro a thick soft-rubber "Nélaton" catheter, secured to the integument with a large pin. Von Bruns used a tampon-canula in the same way. In either instance, subsequent anæsthesia is to be kept up through the tube, the free portion of which presents itself outside of the wound.

In its simplest features, the external relations remaining normal, laryngectomy is practicable as follows: A longitudinal incision is made through the integument in the middle line, reaching from the hyoid bone to the first or second ring of the trachea, care being taken to avoid incision into the tracheal fistula, should a high tracheotomy have been performed. To gain additional room for manipulation, in certain conditions, a second incision is made, cross-wise at the level of the hyoid bone, on each side as required, and in such a direction as will make the flaps most available, reaching, if need be, as far back as the sterno-mastoid muscle. The larynx is then exposed in the median line, as described in speaking of complete laryngotomy (p. 315), and the crico-thyroid arteries are ligatured and divided. Any bursæ or glands in the way may be excised. The soft parts overlying the larynx are then to be detached,

¹ Arch. f. klin. Chir., Bd. xix. S. 507. 1876.

² Ibid., Bd. xxviii. H. 3.

³ Archives of Laryngology, p. 41. 1880.

first from one side, and subsequently from the other. According to Schüller's researches, this is best done by dividing the deep cervical fascia (*fascia profunda colli*, Luschka) immediately enveloping the larynx, so as to afford entrance to an elevator or other blunt instrument, with which the fascia and superjacent tissues may be separated from the thyroid cartilage in mass, and, as far as possible, without the aid of the knife. The thyro-hyoid and sterno-thyroid muscles having been detached from the larynx, and the lateral lobe of the thyroid gland separated with a blunt instrument, without unnecessary rupture of its connections with the trachea—which are useful in restraining descent of the windpipe (Maydl)—the soft parts are to be held to one side with a blunt retractor, and the larynx pulled over to the opposite side with a sharp double hook, so that the constrictor muscles of the pharynx can be divided as close as practicable to their attachments to the thyroid and cricoid cartilages. The thyroid cartilage should then be pulled forwards and to the opposite side, so as to expose the superior laryngeal artery as it penetrates the hyo-thyroid membrane (Schüller). This artery should be secured with two ligatures, between which the knife should be passed in severing the hyo-thyroid membrane and the anterior wall of the pharynx in the next stage of the operation. At this point of the procedure, the important decision must be made as to the disposal of the epiglottis. If it is to remain, the knife is passed through and beyond the hyo-thyroid membrane, and the thyro-epiglottic ligaments are severed. If it is to be removed, the knife is to be carried upwards through the hyo-thyroid membrane instead of backwards, so as to pass between the tongue and the epiglottis, and its course may be controlled (Schüller) by guidance of the left forefinger passed into the patient's mouth. When the lateral portion of the membrane is divided first, the epiglottis can be drawn out, and can thus be protected from the range of the knife in completing the section. The entire larynx is now to be pulled forward by means of sharp hooks inserted at its superior incisure, a blunt tool is to be gently insinuated behind the cricoid cartilage to keep it clear from the posterior pharyngo-œsophageal wall, and the larynx is then to be separated from its further connections with the pharynx and the œsophagus, first laterally, and then from above downwards. Special care is requisite in freeing the cricoid cartilage from the anterior wall of the œsophagus. Any bleeding vessels unattended to during the dissection should now be permanently secured, when, all hemorrhage being under control, the trachea, unless already adherent to the integument, is to be secured by two ligatures, and then the final step of the exsection is taken by severing the larynx from the trachea from behind forwards. Should it be evident, before this final section is made, that the cricoid cartilage is in no way involved in the disease, it is considered highly desirable (Maas, Wegner) to make the section through this part so as to leave a very small strip of the cartilage intact, as an additional support for the adjustment of an artificial substitute for the larynx. Should the cricoid cartilage or its mucous membrane be in any way involved in the disease, the section should be made in the crico-tracheal membrane, or better, perhaps, below the first ring of the trachea. Should the trachea exhibit indications of disease at this point, the section should be made between the second and third rings. The upper end of the divided trachea is finally secured to the integument by several points of interrupted suture.

In suturing the trachea to the integument, Gussenbauer recommends a plan employed by himself: From two to four deep sutures are taken beneath a ring, to secure the trachea firmly to the integument, while several superficial stitches are employed to bring the tracheal mucous membrane into accurate contact with the skin, so that their epithelial layers may become united. The better

to accomplish this result, Gussenbauer deems it desirable to remove, in part or in whole, any projecting anterior portion of a tracheal cartilage in the domain of the line of union. Exact approximation, he contends, insures union by first intention; while secure union of the trachea to the lower corner of the wound in the neck is of considerable importance in the subsequent course of the case.

Should it be deemed preferable, after separating the soft parts from their connection with the larynx, to remove the latter from below upward, the trachea, if not adherent to the integument, is secured by two ligatures, and is then severed from the larynx above the first ring, after which it is stitched to the integument, and securely tamponned. Care must be taken not to "buttonhole the œsophagus." Gussenbauer recommends severance of the trachea with the thermo-cautery. The trachea having been rendered secure, the larynx is to be pulled forward and upward with a sharp double hook inserted into the cricoid cartilage, and the organ is then to be loosened from its connections from below upwards, the final step of the procedure being its separation from the hyoid bone.

In several instances in which this method of excision has been employed, its steps have been disturbed by failure in the air-tight occlusion of the trachea.

In the more extensive operations necessary for the removal of other structures in addition to the larynx, the details of the operation will vary with the conditions of the integument and of the soft parts, the relations of which will have undergone some change. In operating upon these complicated cases, care to cut no vessel before it has been secured between double ligatures will reduce hemorrhage to a minimum, and care to retain as much healthy tissue as practicable will favor the after-treatment. Every source of visible hemorrhage should be controlled by temporary compression, and by subsequent torsion or ligature if necessary.

Unilateral Laryngectomy.—In performing this operation, as described by Hahn,¹ the operator carries an incision towards the diseased side at about the level of the hyoid bone, and makes a second incision in the median line down to the cricoid cartilage. The soft parts are next separated from the thyroid cartilage, which is then split, after which the larynx is carefully inspected. If one half only is diseased, every affected portion is removed—thyroid cartilage, soft parts, arytenoid cartilage, and a portion of the cricoid cartilage. If unilateral exsection is impossible, the cricoid cartilage is not split. The cricoid cartilage is severed from the trachea and the separation effected from below upwards. The œsophagus and the thyro-hyoid membrane are united by sutures.

A long canula is introduced, surrounded with Michael's tampon, and is retained in position for some twelve hours. At each dressing the trachea is tamponned from above with iodoformed sponge.²

AFTER-TREATMENT OF LARYNGECTOMY.—The operation being practically over, both larynx and wound should be rigidly scrutinized as to the thoroughness of the removal of diseased tissue. Any suspected remnants should be immediately excised. Whether the edges of the wound or gap in the anterior pharyngo-œsophageal wall should be united by suture, is a question to be answered, as a rule, in the negative. There is considerable diversity of opinion as to the utility of sutures here. They are often in the way of after-treatment, and they often tear out. Hence they seem advisable only as temporary sup-

¹ Berliner klin. Woch., 16 Juni, 1884, S. 383.

² Hahn, loc. cit.

ports when large portions of the gullet have been removed. In one case, Winniwarter, who has been one of the most successful operators, pulled the anterior wall of the œsophagus in front of the trachea, and secured it with sutures to the cutaneous wound, so as to prevent escape of foreign matters into the air-passages. It seems generally conceded that no sutures should be taken in the integument, except to keep the transverse or oblique edges of large flaps in apposition. The central portion of the wound should be left freely exposed to facilitate drainage, and to aid the manipulations necessary in the after-treatment. When bleeding has ceased, the entire raw surface should be sprayed or douched with an antiseptic solution, a five-per-cent. zinc-chloride solution being preferred by most operators. A thick, soft-rubber catheter of large calibre is then passed into the stomach through the wound, and allowed to project externally. This is secured by a ligature, so that it shall remain in position for several days for purposes of nutrition. The wound is then closely packed with antiseptic gauze or cotton. Salicylic acid, carbolic acid, iodine, or iodoform is used, according to the preference of the operator. The dressings are usually withdrawn and replaced every day, a tampon-canula being in use while the wound is being washed or irrigated. Some operators keep a continuous cloud of antiseptic spray playing over the wound for several days, the more thoroughly to keep it disinfected. Nourishment and stimulus are freely supplied at regular intervals by means of a funnel inserted into the stomach-tube, the external orifice of which is kept plugged at other times. The subsequent management of the case has to be conducted on general surgical principles, it being understood that the whole after-treatment requires the assiduous supervision of the surgeon for at least two weeks, that it will severely tax his patience and his ingenuity, and that it may disappoint him in the end. After a few days, when the track of the wound begins to be firm, the stomach-tube is removed, and replaced only at times of feeding, the patient being encouraged from time to time to try and swallow food. When this can be accomplished,

Fig. 1182.



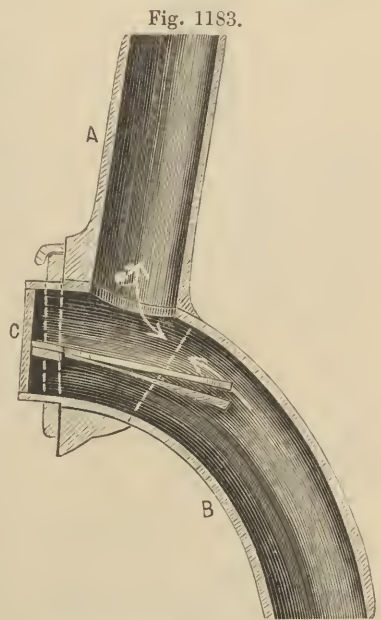
Appearance of parts after laryngectomy. (Lange.)

the stomach-tube is laid aside definitively. In one of Czerny's cases this was practicable after the fifth day. The tampon-canula is usually employed instead of the ordinary tracheotomy-tube as long as any danger of secondary hemorrhage remains, say for a period of eight or ten days. Attempts to introduce an artificial larynx should be delayed until the parts have somewhat assumed their permanent, cicatricial form, say for a period of about two weeks. Too early attempts at its use sometimes produce hemorrhage, while the shape of an apparatus which is adjustable at first, is often useless after cicatrization of the canal of extirpation.

As a rule, cicatrization is satisfactory, so that the integument closes quite up to the orifice of the canula. When a large portion of the integument has had to be removed for disease, or has sloughed away, quite a large and irregular orifice may remain uncovered, as in the case illustrated

by Dr. Lange (Fig. 1182), in the Archives of Laryngology. A defect of this kind interferes materially with the function of deglutition, and necessitates quite a complicated appliance as a substitute for the missing tissues.

ARTIFICIAL LARYNX AND ARTIFICIAL PHONATORY APPARATUS.—Czerny's original experiments included the adjustment of an artificial appliance to replace the excised larynx, and to re-establish a respiratory tract by way of the pharynx and the nasal passages; his object being, in addition, to interpose, in the human subject, a phonal reed to serve as a substitute for the voice. This object was kept in view in the very first laryngectomy undertaken on the authority of his experiments, and an appliance constructed on a design by Gussenbauer, was introduced into the pharyngo-tracheal canal of the patient upon whom Billroth had verified the accuracy of Czerny's indications.¹ It consisted essentially of a tube containing a vibratory reed, intended to be placed at will in the air-space of a sort of T-shaped canula, the upper limb of which reached into the pharynx, and the lower limb into the trachea, while the small horizontal limb was directed forward; such a canula, in fact, as had been used by Richet and others, to re-establish respiration by way of the natural passages, after tracheotomy for stricture of the larynx or other obstruction. The entire appliance comprised three tubes: 1, a tracheal canula, with a large fenestrum on its convex surface; 2, a pharyngeal canula with a similar fenestrum, to be passed through the first one in a reversed direction, so that the two apertures should meet and permit an unobstructed current from the bottom of the lower one to the top of the upper one, thus far representing the old appliance alluded to; and 3, a short adjustable tube fitting into the pharyngeal tube, and supplied with a plate carrying a vibratory reed. The apparatus being in position, the expiratory current on its way to the mouth sets the reed into vibration, producing a sound as in the reed of an instrument of music; and the tone thus produced, broken with articulate speech, serves as a substitute for normal voice. The tone is monotonous, modulation being impracticable. The reed-case is made detachable, so that it can be freed from mucus from time to time. The original apparatus was supplied with a substitute for the epiglottis, maintained erect by a watch-spring weak enough to yield readily to the descent of the base of the tongue in deglutition. This has been found unnecessary, however, and rather in the way. Gussenbauer's tube has undergone a number of modifications, three of which are of special value. First, the reversal of the mechanism of the two air-tubes, so that the pharyngeal air-tube is introduced first, and the tracheal tube through it. Second, grooving the interior of the pharyngeal tube so that the plate carrying the reed can be shoved in and withdrawn after the manner of a table-drawer. These suggestions (Fig. 1183) have emanated from Dr. Irvine, of

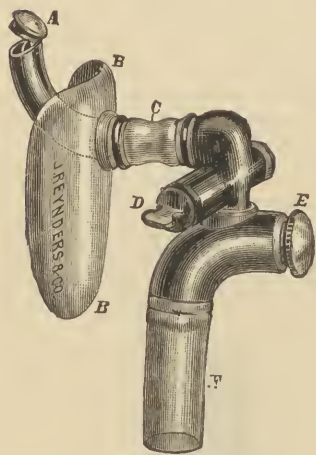


Irvine's modification of Gussenbauer's artificial phonatory apparatus. (Mackenzie, after Foulis.) A. Pharyngeal limb. B. Tracheal limb. C. The phonatory reed.

¹ Arch. f. klin. Chir., Bd. xvii. S 349. 1874.

Glasgow, and were employed in Foulis's case.¹ The third modification alluded to, and which I think is due to Gussenbauer, is a flexible pharyngeal tube, arranged in lobster-tailed links.² Similar flexible appliances have been constructed on devices of V. von Bruns and of Caselli. Heine³ has modified the original device both by flattening the pharyngeal canula and giving it a more rectangular shape, so that it can be directed forward rather than backward and that the conduit can be thus straightened; and by adjusting a turn-key to the reed, so that it can be moved aside when not in use, and thus be less of an obstruction to respiration. Metal, ivory, hard rubber and soft rubber, constitute the chief materials used for reeds. Some observations of my own, years ago, on artificial speech, seemed to indicate that plates of ivory, shaved very thin, would imitate the human voice better than any

Fig. 1184.



Artificial larynx with oesophageal obturator. (Lange.) A. Epiglottis. B. Artificial anterior wall of the oesophagus. C. Soft rubber connection. D. Chamber containing removable vocal bands. E. Rubber cork, removable for opening or closing the tracheal tube. F. Tracheal tube with lower portion entering the trachea, made of soft rubber.

other material, but I have not the slightest personal knowledge of the working of an artificial larynx in the subject of a laryngectomy.

It is hardly requisite to go into farther details concerning these appliances. Nearly every case is liable to present some individual features requiring an apparatus specially constructed to meet them. Sometimes very complicated apparatus is required (Fig. 1184), as when an attempt is made to supply the missing anterior wall of the oesophagus, as was done in Lange's case.⁴

Great difference is presented in the toleration of these appliances. In some instances they give little trouble, and are used with great comfort. Some subjects bear the naked apparatus well, but cannot tolerate the phonal reed, which may impede respiration, may become obstructed with desiccated mucus, and may yield a tone to every breath of expiration. Some abandon them altogether, and stick to the simple tracheal canula. In some instances, saliva, mucus, and aliment will get into the tubes and descend into the trachea. Some patients prevent the escape of food by plugging the upper orifice with cotton, when they eat. Czerny closed the top of the tube, in one instance, with a sort of hood, and placed the respiratory orifice in the front wall. This orifice was occluded during deglu-

tition by the broad plate of a soft rubber ring, cut in the shape of a sealing-ring and drawn over the top—a cricoid structure at the wrong end of the larynx.

MOTOR DISTURBANCES OF THE INTRINSIC LARYNGEAL MUSCLES.

Motor disturbances of the intrinsic muscles of the larynx often produce subjective symptoms similar to those discussed in connection with diseases of a surgical character, and some of them are to be remedied only by surgical intervention. The cause may reside in disease of the nerve, in disease of the muscle, in disease of the joint, or in cicatricial adhesions. Close scrutiny under

¹ Lancet, January 26, 1878, p. 119.

² Prager med. Woch., No. 31, 1883. Separat-Abdruck.

³ Bohm. Correspondenz-Blatt., No. 17, 1874.

⁴ Loc. cit.

laryngoscopic illumination is essential to a correct appreciation of these conditions. Voice and respiration are the processes whose function is most interfered with. Impairments of voice may be dismissed from extended surgical comment, but impairments in respiration demand special elucidation. Voice and respiration require maintenance of the integrity of the chink of the glottis in both directions. When the chink cannot be properly closed, the voice is impaired; when it cannot be properly opened, respiration suffers. Hence it is with palsies of the muscles by which the chink of the glottis is opened that surgery is most closely associated, whether the loss of power be due to spasm of antagonizing muscles, to paralysis of the inactive muscles, to their atrophy, to their infiltration by inflammatory products, or to their restraint by immobility of the articulations whose movements are ordinarily under their control.

SPASM.—Spasm of the dilating muscles of the larynx, an infrequent phenomenon, possesses the merely negative surgical interest comprised in laryngoscopic assurance that the attending aphonia is not due to disease requiring surgical treatment.

Spasm of the constricting muscles of the larynx is a much more frequent and much more serious disorder, for should the spasm fail to relax, death by suffocative apnoea is inevitable. It is of neuropathic origin, occasionally direct, much more frequently reflex. The spasm is far most frequent in the muscles which bring the vocal bands in contact; but it sometimes occurs in those which bring the ventricular bands in contact, and in those which bring the epiglottis down over the glottis. These spasms produce similar symptoms, most pronounced in the first variety; phonal stridor in inspiration, similar to that observed in acute laryngitis, in croup, in whooping-cough, and when a foreign body is in the larynx. Hence the name *laryngismus stridulus* given to the disorder. It is sometimes choreic in character. It is far the more frequent in children, especially in scrofulous and rickety subjects, usually during the period of the first dentition, and chiefly among those weaned too early, and thereby subjected to gastro-intestinal disorders. It is sometimes fatal, occasionally even in the new-born babe.¹ Spasmodic constriction of the ventricular bands is unusual, but examples are seen in sufficient numbers to make it a subject of remark. It is impossible to decide whether it exists unassociated with spasm of the vocal bands. Spasmodic depression of the epiglottis occurs both in adults and in children. In two published instances² noted by myself, children have died from incarceration of the epiglottis in the cavity of the larynx, so that the belief may be entertained that laryngismus affecting the vocal bands may be associated, at times, with spasm of the muscles (aryteno-epiglottic) which depress the epiglottis. Having witnessed the same spasm of the aryteno-epiglottic muscles in adults, and having been able to insure the patients comparative safety from its unpleasant consequences by teaching them, with their own fingers, how to release the impacted epiglottis, the inference has followed that sudden suffocation at table is sometimes due to impaction of the epiglottis, an opinion which was long before expressed, however, by M. de la Harpe.³

Although usually due in children to reflex irritation of the trifacial nerve in dentition, of the pneumogastric in nutrition, or of the sympathetic and spinal nerves in gastro-intestinal disturbances, yet direct irritation of the pneumogastric or spinal accessory by pressure of enlarged bronchial glands, direct irritation of the meninges by caries of the uppermost cervical vertebra, or of

¹ Miller, Brit. Med. Jour., Nov. 17, 1877, p. 698.

² Op. cit., p. 626.

³ Schweiz. Zeitschrift für Medizin, u. s. w., Nr. 3, 1849; cited by Fischer (op. cit., S. 103).

the base of the skull, and direct pressure on the trachea or nerves by abscess, enlarged thymus, or bronchial glands, have been found after death to have been the cause of spasm of the glottis. Aural disease and nasal disease are occasional causes of spasm of the glottis both in the child and in the adult. In some subjects of locomotor ataxia, and in some subjects with epilepsy, spasms of the larynx, by some termed *laryngeal crises* and *laryngeal vertigo*, occur as part of the natural history of the disease.

Symptoms.—These comprise short series of paroxysms of inspiratory stridor, lasting a few seconds at a time, and recurring at intervals of very variable duration—sometimes associated with cough, sometimes producing unconsciousness, and sometimes followed by eclampsia.

Diagnosis.—The absence of fever, of cough, and of impairment of voice, distinguishes spasm from croup, for which it is most likely to be mistaken. Soreness of the gums, a history of improper feeding, or the detection of other sources of irritation, local or constitutional, may be considered as confirmatory of the diagnosis. Occasionally, a laryngoscopic examination in a sensitive subject produces a spasm of the larynx; and under these conditions, its physical features can be recognized in spasmodic approximation of the vocal bands, or of the ventricular bands, or in spasmodic depression of the epiglottis. In the adult, such a spasm may be produced voluntarily for purposes of laryngoscopic inspection of its mechanism. In a first paroxysm, laryngoscopy is impracticable, but preparation being made beforehand, views of subsequent spasms may be caught in time. Laryngoscopic inspection, after relaxation of the spasm, will reveal the absence of local disease for which the affection might be mistaken.

Prognosis.—Liability to suffocative apnoea during any individual spasm renders the prognosis doubtful to that extent; but relaxation almost always takes place, probably from the anæsthetic effect of retained carbonic acid, often just as suffocation seems inevitable. The ultimate prognosis depends on the nature of the exciting cause and on its susceptibility to treatment. In slight cases, the tendency to spasm is usually overcome within a few days, and recurrences may be prevented or mitigated by the institution of appropriate measures, topical and constitutional. The prognosis, as given by some observers, is much more gloomy than is here indicated. Thus,¹ Barthez and Rilliet had 8 deaths among 9 patients, Hérard 6 out of 7, Reid 115 out of 289, Lorent 77 out of 200, and Salathé 2 out of 24. Rühle considers the prognosis unfavorable on the whole. Wunderlich says that about one-third of all attacked, and the majority of those visited with severe attacks, die. Bouchut says that more than one-half, and Steiner is of the opinion that the great majority, die.

Treatment.—Cold affusions, flagellations, the application of ammonia to the nose, holding the nose to force involuntary inspiration (Schæffer), and searching for an impacted epiglottis, are about all that can be done in the presence of an initial or unawaited spasm. For facilitating relaxation of the spasm in subsequent paroxysms, the warm bath may be kept prepared for immediate use, chloroform or amyl nitrite may be kept ready for use in inhalation; and morphine for use hypodermically. Efforts should be instituted to remove the sources of reflex irritation, which may reside in the mouth, larynx, stomach, intestines, anus, vagina, prepuce, spinal column, or brain. Medicinally, assa-fœtida, chloral, and the bromides may be indicated—or cod-liver oil, iodides, and calcium-chloride—with such general hygienic and dietetic supervision as may best improve the general health.

In cases of repeated threatening spasm in children or in adults, the only

¹ Steffen, Ziemssen's Cyclopædia, vol. vii., p. 1018. New York, 1876.

line of safety may be in the direction of prophylactic tracheotomy. In the presence of actual suffocative apnœa, prompt incision into the air-passageway (meso-chondric laryngotomy) may be the sole means of averting death. In the presence of apparent death by apnœa, the fleeting life may be recalled by immediate incision, and the institution of artificial respiration.

PARALYSIS.—Paralysis of the intrinsic muscles of the larynx may be due to two groups of lesions: *first*, to lack of innervation, whether from disease or injury at the nerve centre, disease or injury of nerve filaments, or compression at the nerve centre or along some portion of the nerve tract; *second*, to disease or injury of the muscular fibres, or to infiltrations between them. Apparent paralysis may be due to mechanical restraint—most frequently an anchylosis at the crico-arytenoid articulation, whether true or false. Paralysis may be functional or organic. *Functional paralysis* needs little comment here. It occurs chiefly in hyperæsthetic and hysterical subjects, is almost exclusively bilateral, and is usually readily amenable to measures medicinal and psychical. *Organic paralysis* may be unilateral or bilateral, and either form may be partial (paresis) or complete. It may be in the domain of either the superior or inferior laryngeal nerve, or it may involve both. It may be limited to the larynx, or it may be associated with paralysis of the pharynx or palate, or with regional paralysis, or with general paralysis. Thus paralysis in the domain of the recurrent laryngeal nerve may be part and parcel of so-called bulbar paralysis, of disseminated cerebro-spinal sclerosis, of progressive muscular atrophy, of tabes dorsalis, or of intra-cranial lesions due to hemorrhage, effusion, gumma, tubercle, or neoplasm, in the domain of the origin of the eighth pair of nerves, at the floor of the fourth ventricle. Tracing the functional activity of the structures to which the terminal extremities of the cranial nerves are distributed, the location of the lesion may be inferred with considerable accuracy, and its extent determined within limits of great probability. Paralysis in the domain of the superior laryngeal nerve is most frequent after diphtheria. Unilateral paralysis is usually due to local disease or injury, whether cerebral or peripheral. Bilateral paralysis is usually due to cerebral lesion—to central systemic poisoning, whether septic (diphtheria, pyæmia) or toxæmic (plumbism, nicotism, for example), or to bilateral injury. It is the occasional result of unilateral pressure,¹ Dr. Johnson's² explanation being that the irritation conveyed by the afferent filaments to the centres, sets up such disturbance there as to impress the efferent filaments of both sides, and thus cause bilateral paralysis.

That section or other injury of the recurrent nerve would entail aphonia, was known to Galen, who reported³ one case of an infant attacked with cervical adenitis, and who lost part of its voice, having fallen into the hands of an ignorant person who cut one of these nerves; and another, in which the section was made upon both sides, the person remaining permanently mute. Bilateral paralysis with consequent aphonia occasionally follows severe operations in the cervical region, such as extirpation of the thyroid gland. When due rather to severe handling of the nerve than to actual section, the paralysis gradually subsides, and voice is regained.

Laryngeal paralysis, save, perhaps, that following diphtheria, is much more frequent in adults than in children. Stoerk appears to have been the first observer who recognized this condition laryngoscopically. Organic laryngeal paralysis is most frequently found as a complete paralysis of the recurrent nerve, the vocal band remaining immobile in about the same position

¹ Johnson, Med.-Chir. Trans., vol. lviii. p. 29; Baumler, Arch. f. klin. Med., 22 Feb. 1867.

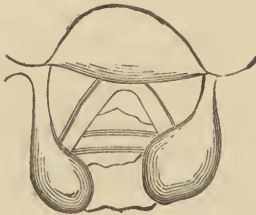
² Transactions International Medical Congress, vol. iii. p. 221. London, 1881.

³ Mérat, Dict. des Sci. Méd., t. xxxiv. p. 285. Paris, 1818.

that it occupies in the dead subject¹ (*cadaveric position*, Ziemssen), that is to say, nearly midway between its extremes of excursion. When both sets of fibres are not involved, the paralysis is much the more frequent in the domain of the filaments which supply the posterior crico-arytenoid muscles (paralysis of abductor muscles), and the vocal band is unable to leave the phonatory position in the middle line. When the paralysis is confined to the domain of the filaments which supply the lateral crico-arytenoids, the arytenoid, and the thyroid-arytenoid—a very rare combination (paralysis of adductor muscles)—the vocal band remains immobile in the position of extreme inspiration.²

Although paralysis of the dilator muscles (*abductors*, Mackenzie) of the glottis had long been recognized³ and its clinical aspects appreciated, its general pathological significance had escaped detection until announced by Semon, in a well-conceived and well-written clinical essay,⁴ “On the proclivity of the abductor fibres of the recurrent laryngeal nerve to become affected sooner than the adductor fibres, or even exclusively, in cases of undoubted central or peripheral injury or disease of the roots or trunks of the pneumogastric, spinal accessory, or recurrent nerves.” In a less well-conceived but equally well-written article,⁵ Dr. Semon expresses the opinion that the dilators of the glottis always suffer first in organic diseases of the centre, or of the tract of the motor laryngeal nerves, by reason, as he intimates, of a physiological necessity which precludes the occurrence of initial or exclusive paralysis of the constrictors (*adductors*, Mackenzie) as a result of organic nerve lesion. From this sweeping conclusion I must dissent, or confess an inability to discriminate between the position of the vocal bands in extreme abduction—their position during forced inspiration—and their position in relaxation (*cadaveric position*, Ziemssen). A pair of rude sketches (Figs. 1185 and 1186), reproduced from the first edition of my work on Diseases of the

Fig. 1185.



During respiration.

Fig. 1186.



During attempted phonation.

Throat, etc.,⁶ in illustration of unilateral paralysis in a case of aneurism of the aorta, the significance of which was unappreciated at the time, are sufficiently characteristic to show that the vocal band is in extreme abduction; but some artistic drawings of the laryngoscopic images (Figs. 1187, 1188, 1189) in a case of paralysis of the left vocal band in extreme abduction, following an incised wound of the neck, and recently reported to the American Laryngological Association,⁷ better illustrate the position referred to, although they have been somewhat spoiled in their reproduction on wood.

Mackenzie has met with one case in which paralysis of the adductors was

¹ Tuerck, op. cit., S. 442.

² For normal picture of extreme inspiration, see Fig. 1134, p. 280.

³ Gerhardt, Virchow's Archiv, Bd. xxvii., S. 68, 296. 1863.

⁴ Archives of Laryngology, July, 1881, p. 197.

⁵ Berliner klin. Woch., No. 46. 1883.

⁶ Op. cit., p. 466. New York, 1872.

⁷ New York Medical Journal, July 26, 1884.

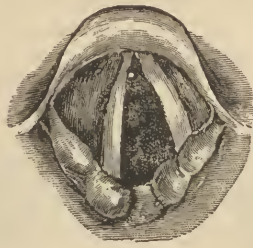
caused by extensive disorganization of the brain from carcinoma;¹ and Cheesman,² a case of unilateral paralysis from aneurism of the arch of the aorta, in

Fig. 1187.



Forced inspiration.

Fig. 1188.



Expiration.

Fig. 1189.



Attempted phonation.

which the abduction of the vocal band was sufficient to enable him to distinguish the pulsations of the aneurism at the terminus of the trachea. It seems plausible, as suggested by Rossbach,³ that, in accordance with analogy in muscular functional activity elsewhere, the abductors (dilators) should suffer first in all cases of paralysis of the recurrent nerve, in the same manner that the extensors and abductors are paralyzed first in all other cases of paralysis of nerves or nerve-centres, while the sphincters, which correspond to the adductors (constrictors) of the larynx, are attacked last. This does not necessarily exclude the possibility of exceptions to the rule. But the uncertainty as to the part that the superior laryngeal nerve may take in the innervation of the arytenoideus muscle, and the intricacy of the bilateral innervation of that muscle for duty on the two sides, present so many features for recognition, that the etiology of pure adductor-paralysis, as well as of other forms of laryngeal paralysis, awaits satisfactory elucidation in the very face of the striking laryngoscopic pictures of paralysis under almost continuous observation. It is not known whether the double function of the recurrent laryngeal nerve is due to innervation by a common centre, or whether distinct centres preside over separate sets of filaments; while the influence which the nucleus of the pneumogastric may exercise upon abduction of the vocal bands as an organic feature of the respiratory act, is a problem yet unsolved.

Paralysis of long duration often leads to degeneration of the nerve, and to degeneration and atrophy of the inactive muscles. Inaction of the muscles may lead to ankylosis, as in articulations generally.

Diagnosis.—While paralysis of the intrinsic muscles of the larynx may be inferable from objective symptoms, its due recognition necessitates laryngoscopic inspection.

Paralysis of the posterior crico-arytenoid muscle (abductor, Mackenzie) is recognized by fixation of the vocal band in the phonatory position. Unilateral paralysis is, for anatomical reasons, much more frequent on the left side. Bilateral paralysis comes especially under the domain of surgery, for inspiratory dyspnoea is then so urgent that suffocation becomes imminent, and sometimes inevitable, unless prophylactic tracheotomy be performed, especially when any tendency is manifested to spasm of the antagonizing muscles. The vocal bands cannot be abducted to any distance by the most powerful

¹ Hoarseness, Loss of Voice, and Stridulous Breathing, pp. 4-6. London, 1868.

² Med. Record, Sept. 22, 1882, p. 335.

³ Breslauer aerztliche Zeitschrift., Nos. 2 und 3, 1880; Trans. International Medical Congress, vol. iii. p. 222. London, 1881.

effort; while in marked instances, or during spasm of the antagonists, they cannot be abducted at all. (Fig. 1190.) During inspiration, the vocal bands are drawn so strongly downwards in closer and closer approximation, that sometimes the mucous membrane passes the edges of the fibrous tissue—which then become very prominent beneath it—and vibrates during the stridor. In expiration, the vocal bands are driven upwards in a vaulted manner, and

Fig. 1190.



Fig. 1191.



Bilateral paralysis of posterior crico-arytenoid. Inspi-
ration. Patient wearing a canula.

Bilateral paralysis of posterior crico-arytenoid muscle.
Expiration. Patient wearing a canula.

the elliptic or acutely triangular chink of the glottis undergoes enlargement, so that the air passes freely out of the larynx. (Fig. 1191.) Sometimes the picture resembles that of paralysis of the thyro-arytenoids during phonation. In some instances¹ unilateral paralysis precedes the bilateral. Bilateral paralysis sometimes so closely resembles actual adhesion of the opposing faces of the arytenoid cartilages, as to render the diagnosis uncertain from inspection only; while, in its turn, the latter condition may be mistaken for paralysis.² There is no loss of voice in either unilateral or bilateral paralysis, although its quality may be impaired; but there is a peculiar mode of utterance in bilateral paralysis, due to interruptions by prolonged strident inspirations. There is no dyspnoea in unilateral paralysis except on slight exertion, or from intercurrent disease. There is great dyspnoea in bilateral paralysis—extreme, labored, and strident in inspiration; moderate or unnoticed in expiration, unless on exertion—while the inspiratory stridor, especially during sleep, may be so very loud as to be heard in adjoining apartments, or throughout the house.

Paralysis of the crico-thyroid muscles (tensors, Mackenzie) is indicated merely by unevenness in the outline of the edge and upper surface of the vocal band, which is usually congested, and sometimes exhibits pearlish refraction. Should these indications be so slight as to create doubt in diagnosis, reliance is placed mostly upon a lack of precision in phonation—a peculiar, dissonant slide occurring occasionally or frequently during conversation—and upon the fatigue or even pain produced by prolonged vocal effort.

Paralysis of the thyro-arytenoid muscles, the regulators of tension (relaxors, Mackenzie; distenders, Elsberg)—Indian-bow paralysis (German writers)—one of the most frequent forms of laryngeal paralysis, is recognized by approximation of the vocal bands posteriorly, with central enlargement of the chink of the glottis, the orifice being elliptic when the paralysis is bilateral (Fig. 1192), and Indian-bow shaped when unilateral (Fig. 1193). This paralysis is sometimes associated with paralysis of the arytenoid muscle, as indicated by

¹ Cohen, op. cit., p. 654.

² Sidlo, cited by Ziemssen (Cyclopædia of the Practice of Medicine, vol. vii. p. 969). See Luxation of the Larynx, *supra*, p. 258.

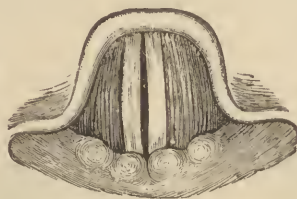
incompleteness of the ellipse posteriorly, and by the appearance of a second ellipse, or rather a hemi-ellipse, behind the unapproximated vocal processes of the arytenoid cartilage (Fig. 1194).

Fig. 1192.



Bilateral paralysis of thyro-arytenoids in acute laryngitis. (Ziemssen.)

Fig. 1193.



Paralysis of right thyro-arytenoid. (Ziemssen.)

Fig. 1194.



Bilateral paralysis of the thyro-arytenoids, with paralysis or paresis of the arytenoid muscle. (Ziemssen.)

The impairment of phonatory power is manifested chiefly in modulation; but if sufficient effort be made, the voice can usually be held. Its quality is unpleasant under either condition; and vocal effort is fatiguing or even painful. In bilateral paralysis associated with paralysis of the arytenoid muscle, there is dysphonia or aphonia as the case may be.

Paralysis of the lateral crico-arytenoids, usually associated with paralysis of the arytenoid and of the thyro-arytenoid muscles, when of organic origin, is shown by immobility of the vocal band at the extreme limit of its outward excursion. (Figs. 1186, 1188, pp. 378, 379.) On the side involved, the glottis is opened to its widest extent. The paralyzed vocal band fails to advance to the phonatory line in attempted phonation, but the non-paralyzed band will cross the middle line, so that its arytenoid cartilage will stand in front of the other one (Fig. 1189, p. 379), and the lost tension of the thyro-arytenoid may permit the paralyzed vocal band to be bowed upward in the expiratory current. There is aphonia, or at most an exhalatory substitute for voice, hardly phonal in a proper sense. Paralysis of functional origin, sometimes disassociated from paralysis of the arytenoid and thyro-arytenoid muscles, is indicated by its almost unexceptionally bilateral manifestation; the vocal bands remaining very nearly in the respiratory position, with failure of approximation in attempts at phonation, although a weak, incomplete advance, or advance and immediate retreat, is observed in some instances, as though the patient "could not will" to bring the bands together. Approximation of the bands with resultant sound may take place in movements of sneezing, coughing, and laughing. There is no voice, or there is dysphonia with intermittent aphonia. The patient speaks in a laryngeal whisper, with "a phonative waste of breath." (Ziemssen.) In complete paralysis there is absolute aphonia, cough is aphonic and weak, and there is no power to make the explosive "hem."

Paralysis of the arytenoid muscle (central abductor, Mackenzie) is recognized by failure in closure of so much of the glottis (*intercartilaginous glottis* of some authors) as lies behind the anterior extremities of the vocal processes of the arytenoid cartilages. The voice is impaired, and is marked by a perceptible expiratory current of unused air, which makes talking fatiguing.

Paralysis of all the filaments in the domain of the recurrent nerve, adductor and abductor—*paralysis of the recurrent*—is recognized by immobility of the

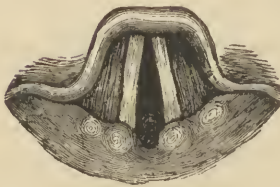
vocal band nearly midway between the positions for phonation and for deep inspiration, a little within the ordinary respiratory position (Fig. 1196), the cadaveric position of Ziemssen (Fig. 1197). This position has often been mistaken for that of extreme abduction, and has thus led to unnecessary confusion in the recognition of individual laryngeal palsies. In unilateral paralysis, the unaffected vocal band often crosses the line in phonation, its arytenoid and supra-arytenoid cartilages passing in front of their fellows (Fig. 1196).

Fig. 1195.



Paralysis of arytenoid; acute laryngitis. (Ziemssen.)

Fig. 1196.



Bilateral paralysis of recurrent nerve. (Ziemssen.)

Fig. 1197.

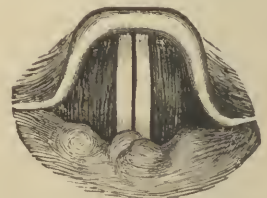


Position of the vocal bands removed from a recent cadaver. (Ziemssen.)

Dysphonia exists in unilateral, and aphonia in bilateral paralysis. The "phonative waste of breath" (Ziemssen) in speaking, is sometimes so marked as to indicate the character of the lesion independently of the laryngoscope. This form of complete paralysis of the recurrent seems (Semon) to be almost invariably preceded by paralysis of the abductor filaments only, the vocal band remaining fixed in the phonatory position, and receding to the cadaveric position only when the adductor filaments become paralyzed. This initiatory phase of the paralysis being usually unilateral, does not affect the voice, and hence escapes recognition; laryngoscopic inspection being rarely instituted until impairment of voice has resulted from complete paralysis in the cadaveric position. Semon suggests that more frequent examination of individuals with nerve-lesions will verify the accuracy of this observation.

Laryngoscopic inspection reveals the character of the palsies of the larynx, but it does not always detect the lesions which produce them, even when myopathic merely. To complete the diagnosis, it is necessary to interrogate the constitutional integrity of the patient, and to pass in review all possible

Fig. 1198.



Crossing of arytenoid cartilages. (Ziemssen.)

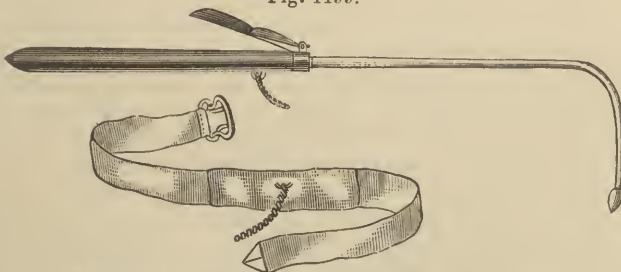
sources of lesion which, from the nerve-centre to its laryngeal filaments, might be productive of the paralytic condition detected. Paralysis of a vocal band sometimes furnishes the first intimation of the existence of an aneurism of the arch of the aorta; and an autopsy sometimes verifies the accuracy of the diagnosis, even when the ordinary physical signs have eluded detection,¹ as in aneurisms located posteriorly. So too with other affections. Paralysis of the recurrent in laborers accustomed to lift heavy weights, should always suggest the possibility of aneurism. In individuals who do not work hard, it may be one of the precursory manifestations of carcinoma.

Prognosis.—The prognosis depends upon the causal lesion. If this can be cured or removed, the paralysis may be remedied, if nerve and muscle have not suffered irreparable injury. Thus the prognosis is unfavorable in paralysis due to carcinoma of the œsophagus, to intra-thoracic tumor, to aneurism of the aorta, and so on. In paralysis of central origin, the prognosis is presumptively favorable only when that origin is syphilitic. It is much less favorable in systemic poisoning, whether diphtheritic or toxic, although recovery usually ensues in slight cases of diphtheritic paralysis, and often without treatment.

In paralysis of functional origin, and in paralysis due to recent inflammation, the prognosis is exceedingly favorable; yet results do not invariably sustain the prognosis.

Treatment.—Treatment of the underlying lesion is the best method of attacking the paralysis. It often fails, especially when degenerations have taken place in the paralyzed nerve or in the palsied muscles. In bilateral paralysis of the posterior crico-arytenoid muscles, organic in origin, prophylactic tracheotomy should precede other treatment, so that life may be secured from sudden cessation by suffocation. Only in exceptional instances can this important step be justifiably postponed. Rarely can it be ignored. Without it, topical manipulations of any kind are hazardous in the extreme. Strychnine by the mouth, or by hypodermic injection, is the drug of greatest value in most instances of laryngeal paralysis, especially those following diphtheria. Specific treatment is to be instituted in cases which are syphilitic in origin; and antidotal treatment in cases of drug-poisoning. When nerve and muscle have undergone little organic change, direct electrization to the affected muscle, or to the most superficial portion of the nerve-tract which is accessible, will often produce in time a happy response—sometimes an immediate response—especially in cases of functional character, even when of several years'

Fig. 1199.



Mackenzie's laryngeal electrode, and electrode for the neck.

duration. Sudden restoration of voice in this manner sometimes impresses the unsophisticated patient like the mystic paraphernalia of a wizard. The source of the electricity, whether battery-current or induction-coil, seems to

¹ Cohen, Am. Journ. Med. Sci., July, 1883, p. 89.

be a matter of indifference. The electric treatment has been especially simplified by Mackenzie, who has perfected its technical details by adapting the interrupter of the electric cautery to the handle of the laryngeal electrode (Fig. 1199), and by attaching the stationary electrode by a strap to the neck.

IMMOBILITY OF THE VOCAL BANDS FROM MECHANICAL RESTRAINT.—This may be due to inflammatory tumefaction, to inflammatory adhesions, to tumor, to traumatism, to cicatrization, or to false or true ankylosis of the crico-arytenoid articulation.¹ Most of these causes have been discussed. *Ankylosis of the crico-arytenoid articulation* occurs chiefly from perichondritis, and more frequently in syphilis and in the perichondritis following enteric fever; occasionally from arthritic synovitis. In a case under my own care, the ankylosis appeared to be the result of inaction, consequent upon fibroma of the vocal band. The diagnosis is made out by laryngoscopic inspection, and can sometimes be confirmed by palpation with the finger. The pictures seen in the mirror so closely resemble those of paralysis, that discrimination may be difficult unless the history of the case be given due consideration. Asymmetry of the cartilages on the two sides, or tumefaction, may suggest the existence of ankylosis. The symptoms are similar. Surgical treatment by tracheotomy may be required to insure freedom from dangerous dyspnoea.²

APNŒA.

Apnœa (*a privative*, and *πνέω*, I breathe), breathlessness, is used, as a medical term in two senses. Experimental physiologists employ it to indicate the arrest of the respiratory movements observed when the blood is suddenly supplied with an overplus of oxygen—it being well recognized that the respiratory centre in the medulla oblongata is excited by an excess of carbonic acid in the circulating blood, and quieted, or even paralyzed, by excess of oxygen. The terrific muscular efforts observed in the domain of the respiratory motor apparatus, when suffocation is imminent, are quite familiar to practitioners generally; and the momentary suspension of the respiratory act upon sudden abundant access of atmospheric air to the lungs of a cyanosed patient, through an incision just made into the trachea, is quite as familiar to those who have seen much of tracheotomy. This apnœa may lead a surgeon off his guard, to dread, for the moment, that death has ensued at the very instant in which he has secured to his patient a fresh lease of life.

Clinically, the term apnœa is used by many physicians to designate death by suffocation—the word being more accurate, etymologically,³ than the conventional term asphyxia (*a privative*, and *σφύζω*, I throb), pulselessness. It is true enough that the death ensues on the cessation of the circulation; and that in many instances of apparent death by apnœa, resuscitation may take place if artificial respiration be instituted before the heart has ceased beating; nevertheless, asphyxia, the final stage of the process, is the result of the apnœa, and not itself the mode of death. Strictly speaking, all death is by apnœa—want of breath—but medically speaking, the term is restricted to death due to sudden stoppage in the aëration of the blood. It may be defined then as cessation of respiration from inability of continuance by reason of insufficiency of oxygen, although there be no immediate cessation of the respiratory act.

Thus apnœa is the mode by which death ensues in all forms of sudden

¹ Medical Record, July 1, 1869, p. 218.

² For an elaborate discussion of this subject, see Semon (Med. Times and Gaz., vol. ii. 1880); Reprint, London, 1880.

³ Watson, Lectures on the Principles and Practice of Physic, p. 44. Philadelphia, 1844.

obstruction in the access of atmospheric air to the lungs, and consequent failure in arterialization of the blood. The apnœa may be produced by smothering, throttling, hanging, or drowning; by exposure to mephitic gases, vapors, or fumes; by mechanical occlusion of the air-passage by a foreign body, a neoplasm, or a pathological product; by mechanical compression of the larger air-passages, of the thorax, or of the lungs; by effusion into the air-cells; by collapse of the air-cells; or by spasm of the glottis. In many instances, death, from these causes, is not by apnœa simply, but sometimes by injury to the spinal cord in addition—as in hanging—or by apoplexy from compression of the jugular veins. In some, as when caused by inhalations of chlorine, chloroform, sulphuretted hydrogen, or carbonic oxide, it is more death by a direct poisoning than by mere deprivation of oxygen. Other causes of apnœa are neurotic, such as paralysis of the respiratory centre in disease or injury of the medulla, and paralysis of the nerves or muscles of respiration, including paralysis of the posterior crico-arytenoid muscles, which maintain the patency of the glottis.

Trained individuals are able, without extraneous aid, to suspend the process of respiration voluntarily for two or three minutes; but in other subjects a suspension of the process for less than two minutes is sufficient to cause death by apnœa. Resuscitation after prolonged suspension is presumptive proof that indistinguishable movements of respiration have been going on to an extent sufficient to prevent absolute arrest of circulation.

Apnœa by drowning, except under unusual circumstances, is rather quicker than apnœa by other causes—the access of water to the lungs driving out air, the retention of which would have prolonged life for a few additional seconds. Total submersion for two minutes is sufficient to extinguish life, as a rule, unless syncope takes place promptly. Syncope diminishes the immediate need for arterialized blood, and thus suppresses the convulsive muscular movements, which favor expulsion of air from the chest, and favor ingress of liquid. In most instances of drowning, the head comes once or oftener to the surface, permitting additional inspirations of air which prolong existence; and most examples of recovery after apparently prolonged submersion are to be explained in this manner.

The mechanism of the arrest of circulation in death by apnœa has long been in dispute, despite numerous autopsies and innumerable experiments upon animals. The views promulgated by Prof. George Johnson, of London,¹ and based in part upon some experiments performed for him by Prof. Rutherford, have recently been reinforced in such strong terms by Dr. Alexander Harvey, of Aberdeen,² that it is desirable to present them here in brief. According to this theory, the capillary vessels of the lungs are virtually bloodless at the moment of death, and the lungs themselves are collapsed and anæmic throughout at their base. While the capillaries are virtually empty, minute quantities of blood remain arrested in them at points immediately contiguous to the terminal extremities of the arterioles. This state of things is attributed to mechanical arrest of blood in the pulmonic arterioles, in consequence of an energetic, though not instantaneous, contraction of the muscular arterioles; so that minute portions of blood remain caught at the points designated, although the contents of the capillaries as a whole have become emptied into the venules. It is to the presence of multitudes of these minute collections of blood, still accessible to air which might be conveyed to the air-cells, that resuscitation by artificial respiration is believed to owe its feasibility. The contraction of these muscular arterioles is attributed to the

¹ Lumleian Lectures on the Muscular Arterioles. Reprinted from the Brit. Med. Jour., 1877.

² Med. Times and Gaz., Dec. 1 and 8, 1883, pp. 622, 649.

poisonous influence of venous blood which, as such, has already made one complete circuit through the systemic capillaries, after arterialization had ceased. On the contraction of the arterioles, checking, as with compressors, the progress of the blood into the capillaries of the lungs, the pulmonic blood-pressure becomes augmented, and the right side of the heart—the auricle especially—becomes over-distended; while the left auricle, relieved of previous distension by a similar though less forcible action of the systemic arterioles, becomes quite flaccid; the two ventricles being, at the same time, in corresponding relative positions. In connection with this subject, Dr. Johnson quotes from Harvey's *Second Disquisition on the Circulation of the Blood*, as follows:—¹

“I have several times opened the breast and pericardium of a man within two hours after his execution by hanging, and before the color had totally left the face, and in presence of many witnesses, have demonstrated the right auricle of the heart and the lungs distended with blood; the auricle in particular of the size of a large man's fist, and so full of blood that it looked as if it would burst. This distension, however, had disappeared next day, the body having stiffened and become cold, and the blood having made its escape through various channels.”

In support of this fact, denied by some recent writers on apnœa, additional evidence is given from a similar autopsy, and from a number of experiments upon animals.

From this account, it would appear that at the moment of death by apnœa, the left side of the heart is not full of blood, while the right side is greatly distended owing to the blocking of the blood in the pulmonic arterioles; and that the circulation is arrested in this condition. The pulmonary artery is full, and can receive no more blood from the distended right ventricle; the right ventricle is full, and can receive no more blood from its auricle; and the auricle remains filled in over-distension.

In some experiments on animals instituted for me by Dr. Solomon Solis-Cohen and Dr. Brubaker, in the physiological laboratory of Jefferson Medical College, it was found, after death by tying the trachea, that the right side of the heart was enormously distended in both chambers, while the left side contained blood, but was not full in either chamber. The pulmonary artery, the venæ cavæ, and the portal vein were also markedly distended, and there appeared to be general engorgement of the venous system. The lungs were not collapsed at death, for the air rushed out of the trachea when the ligature was cut; but on dissection, collapse was evident. At the moment of opening the chest, the lungs were anæmic throughout, and the upper portion of both lungs, and their anterior and lateral peripheries, remained exsanguine; but there very soon appeared diffuse congestion at the base and the dependent portions posteriorly. Animals submitted to death by drowning presented little difference as far as the circulatory system was concerned, except that the left heart was quite full, cardiac action having ceased in diastole; but the lungs were collapsed, and exhibited intense congestion, more marked at the base and in the central portions, the borders being somewhat anæmic. The lungs did not appear to contain water.

Symptoms.—The symptoms of impending apnœa vary within extreme limits, according as it is slow or rapid in disease, or sudden and overwhelming in injury. The symptoms as presented in occlusion of the air-passage by cedema, by a foreign body, by false membrane, by spasm, and by paralysis, have already been described.²

¹ Works, etc., transl. by Willis, p. 127. London, Sydenham Society, 1847.

² See pages 247, 266, 300, 301, 375, and 377, *supra*.

Except in slow apnœa, the symptoms are usually sufficiently pronounced to be comprehended by anybody. They consist in general agitation, dyspnœa, forcible efforts at respiration, failure in the process, and coma. Thus in sudden apnœa, with some modifications in severity and sequence, intolerable discomfort—primarily from sensations of a load within the thorax and of compression without—which cannot be gotten rid of or overcome, induces an uncontrollable desire to breathe, and causes the patient to start up or change his position for one in which he either can get air more easily, or can fight for breath more efficiently with the aid of the voluntary muscles of respiration. His countenance expresses both dread and anxiety; he looks from one bystander to another in mute imploration for help; and, often unable to stop to speak, he points to his throat, clutches at his neck, or waves his hands in an outward direction. He declares, perhaps, that his head feels full enough to burst; he complains of vertigo, of tinnitus, and of coruscations. His pulse is rapid; his face is congested; the superficial veins of the head and neck are visibly distended; the eyeballs are prominent; the pupils are dilated and irresponsive to stimuli.

The efforts to secure breath are at first frequent, shallow, and weak, but, being insufficient for the purpose, these are soon succeeded by deeper, more prolonged, and more powerful respirations, the action of all the involuntary muscles being called into play; and as the impotency of these desperate efforts exhausts the strength of the patient, he sinks into a position of indifference and inattention, insensible to things about him, and not responsive to reflex stimulation. Meanwhile the pulse has become slow and feeble, the face livid, the lips blue, the mouth occupied with unexpecterated products of secretion, with accumulations of frothy saliva, mucus, and perhaps blood, at the orifice and at the nostrils; sounds in the larynx indicate accumulations there, perhaps from insensibility of the epiglottis; while eclampsia may take place with forcible constriction of the expiratory muscles, and with such relaxation of the sphincter-groups that there may be involuntary discharges of feces, of urine, and of seminal fluid.

The respiration gradually becomes weaker, shallower, and less frequent; and this is succeeded by spasmodic, snapping gasps for breath, which recur slowly at increasing intervals; the pulse becomes intermittent, and then imperceptible; the face becomes covered with sweat; occasional eclampsia is manifested; coma ensues, and respiration is at an end, although faint contractions of the heart may be detected, in some instances, for from two to four minutes longer, when they cease in turn, and true asphyxia—pulselessness—terminates the life of the individual. The apnœa may be so sudden as to anticipate the usual train of symptoms; and the time occupied in the uninterrupted process rarely exceeds ten minutes under any conditions.

Prognosis.—The prognosis is grave. Recovery is possible only in cases of mechanical obstruction in the air-tract, susceptible of relief before the completion of the process; and even then, often, only after prolonged efforts at resuscitation. Resuscitation may be considered possible as long as the heart continues to beat. Failures in resuscitation are not always attributable to failure in securing access of air to the blood, but are often due to the inability of highly carbonized venous blood to absorb oxygen, its capacity for which, according to the researches of Bernard, will have fallen from 139 : 1000 to 85 : 1000. The blue and blue-black color of the blood is attributed by some observers to excess of carbonic acid, and by others to lack of oxygen. It has been found, too, that the blood-globules lose portions of their hæmatocrystalline, which by microscopic inspection (Preyer) can sometimes be found crystallized in the serum. This disorganization of the blood precludes recovery.

Even successful resuscitation does not always insure permanent recovery; for cases are on record in which death has taken place suddenly, several hours after restoration of normal respiration, and without having left sufficient trace of its cause for detection on post-mortem examination.

Treatment.—The treatment of apnœa must be prompt. Allowance being made for special conditions and circumstances, it may be summed up in efforts to remove the cause, and to arouse the respiratory centres. Apnœa of the new-born, resisting flagellations, is usually treated by mouth to mouth insufflation, by insufflation through a catheter or other tube passed into the larynx through the mouth, or by means of a tube passed through an external incision made in the air-passage. In insufflations of this kind, care is requisite not to use force sufficient to rupture the air-cells. Apnœa by hemorrhage requires transfusion; and the same measure may be required in poisoning by mephitic gases, such as carbonic oxide. In ordinary cases of apnœa from drowning and choking, the mouth and nostrils are to be cleansed from occluding matters, all constricting bands are to be promptly loosened, abundant supply of air is to be secured—if necessary by opening the larynx or trachea—and the patient is to be placed in such a position as will best favor respiration. The cause of the apnœa having been removed, attempts are to be made to rouse the respiratory centre by holding ammonia near the nostrils, and by cold and wet flagellations of the cheeks and chest. Should opportunity be presented, efforts may be made to excite movements of the diaphragm by electrization of the phrenic nerve, one electrode from a powerful induction-coil being placed over the course of the nerve in the neck, and the other electrode being applied at the epigastrium. In absence of prompt response to these measures, resort to be had to artificial respiration.²

[INTUBATION OF THE LARYNX AS A SUBSTITUTE FOR TRACHEOTOMY IN CASES OF LARYNGEAL STENOSIS.]

To Desault, in the end of the last century, appears to belong the credit of having first demonstrated that the larynx would tolerate the presence of a tube, and this distinguished surgeon is reported to have saved the life of a patient affected with œdema of the glottis, by introducing a catheter, and allowing it to remain in the larynx for two days and a half. Desault's recommendation of intubation as a substitute for tracheotomy was renewed by Bouchut, in 1858, but the practice did not find favor with the profession generally, and Trousseau's dictum, that tracheotomy was to be adopted when medical measures failed, in cases of croup, continued to express the prevailing opinion among practical surgeons. Within the last few years, however, laryngeal intubation has been revived, or, more properly, re-invented, by Dr. O'Dwyer, of New York, who has devised ingenious instruments for the purpose, and the operation is now being very extensively employed in this country, and with results which compare not unfavorably with those of tracheotomy, the proportion of recoveries among 806 cases collected by Dr. Dillon Brown having been 27.4 per cent. The annexed illustration (Fig. 1200) shows the instruments employed by Dr. O'Dwyer, and the following account of the method of using them is condensed from a paper read by Dr. Huber before the New York Academy of Medicine:—

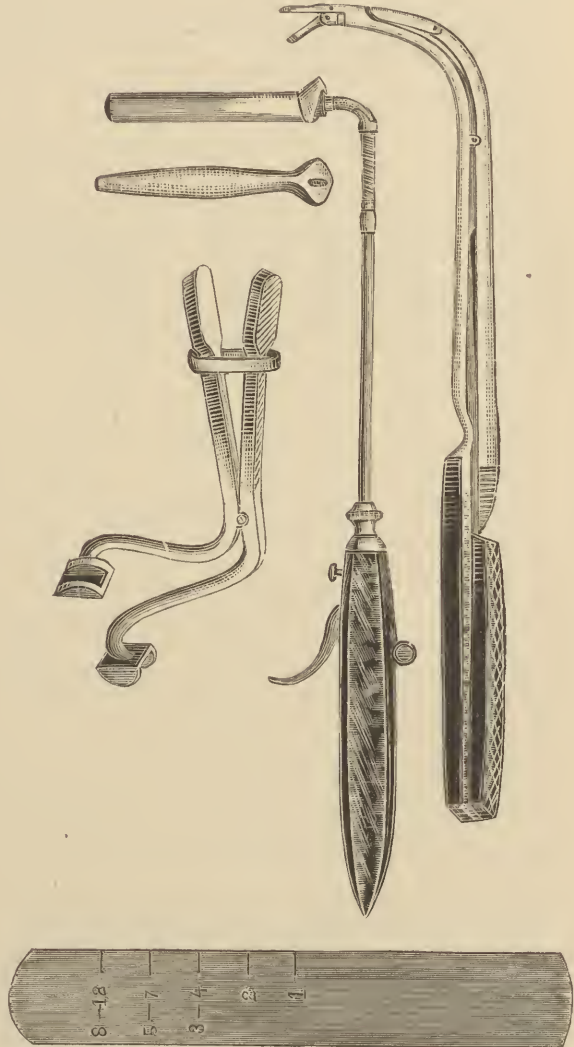
² See Vol. I., pp. 520–522.

The number on the scale indicates the years for which the corresponding tubes are suitable. For instance, the smallest tube, when applied to the scale, will reach to the first line, marked 1, and is to be used up to the age of 12 or 15 months; the size marked 2 is suitable for the next year; 3 and 4 for these years, and so on. When the proper tube is selected, a fine thread is passed through the small hole near its anterior angle, and left long enough to hang out of the mouth; its object being to facilitate the removal of the tube, should this be found to have passed into the œsophagus instead of the larynx. The obturator is screwed tightly to the introducer, to prevent the possibility of its rotating while being inserted and passing into the tube, the groove in the upper extremity of the obturator being made to correspond to the small hole in the tube intended for the string. The tube is introduced without the aid of anaesthesia, the child being held upright in the arms of a nurse, with the gag in the left angle of the mouth, well back, and opened widely. An assistant holds the head, thrown somewhat backward, while the operator inserts the index-finger of the left hand to raise the epiglottis and guide the tube into the larynx.

The handle of the introducer is held close to the patient's chest in the beginning of the operation, and rapidly elevated as the canula approaches the glottis. The tube is then pushed downward, without using much force, and is detached, the joint in the shank of the obturator facilitating this part of the procedure. As soon as the obturator is removed, and it is ascertained that the tube is in the larynx, the thread is withdrawn, the finger being kept in contact with the tube to prevent its being withdrawn also. The attempt at introduction should be made quickly, as breathing is almost suspended from the time the finger enters the larynx until the obturator is removed, and several short efforts are therefore safer than one long one. Successful introduction is indicated by the occurrence of a paroxysm of coughing, and by the relief of dyspnoea.

To remove the tube, the patient is held as for its introduction, except that the head is not inclined backward, or very slightly so; the extractor is passed into the tube, guided by the left fore-finger, and is brought in contact with the head of the canula. Firm pressure with the thumb is then made on the lever above the handle, while the tube is being withdrawn. If secondary dyspnoea should occur at any time, the tube should be removed

Fig. 1200.



and a larger one substituted. Should the case progress favorably, the tube may be dispensed with about the fifth day.

The advantages of intubation over tracheotomy are, it seems to me, that the risk of hemorrhage during the latter operation is avoided, that the parents of a child may be more willing to permit the introduction of a tube than any procedure involving the use of a knife, and that, after recovery, when the tube is removed, there is no external wound remaining; its principal disadvantages are the risk of the tube slipping down into the trachea, or, on the other hand, being coughed up and swallowed, and above all the difficulty of feeding the child while the tube is in place, liquids being very apt to enter the air-passage during the attempt to swallow, and a low and fatal form of pneumonia being then likely to supervene. The risks of the tube becoming clogged with mucus or false membrane, and of pushing membrane down in front of the tube, may also be incurred in using the tracheal canula after tracheotomy. Intubation is probably somewhat easier of execution than tracheotomy, though its advantage in this respect is, I believe, exaggerated. Upon the whole, my judgment in regard to the matter is that, while intubation is a very valuable addition to our means of treating croup and diphtheria, I should feel safer, if circumstances permitted, in making an external opening below the seat of obstruction and introducing as large a canula as the trachea would accommodate, rather than in trusting to a small tube introduced into the larynx *per vias naturales*.]

INJURIES OF THE CHEST.

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CONTUSIONS OF THE CHEST.

THE division commonly adopted in the classification of wounds of the chest, may be employed with advantage in considering the subject of its contusions without wound. In the first group may be placed the contusions which implicate the walls only of the chest ; in the second, contusions of the thoracic viscera.

CONTUSIONS LIMITED TO THE THORACIC PARIETES.—The elasticity of the chest-wall, and the free mobility of its integument and of many of the muscles which compose it, render the effect of blows less important here than in many other parts of the body, provided that their force is insufficient to break the bones or the costal cartilages. Such injuries give rise to ecchymoses of moderate extent, and but seldom to circumscribed bloody tumors such as are commonly seen on the head and in the limbs, as the result of bruises of the tissues which cover firmly resisting bones. For the same reason, concussion rarely affects the thoracic viscera in consequence of blows on the chest-wall, if we exclude, as we must do in this article, the injuries of the spinal segment of the wall. Again, sloughing of the skin or of the areolar tissue of the chest-wall rarely occurs after contusions, because of their slight effect on tissues which are backed by an elastic support, and which are freely movable on that support. Abscess of the chest-wall, following contusion, is also a rare phenomenon, except in the form of symptomatic abscess arising indirectly, that is, from a limited caries or necrosis of a rib, or of the sternum ; indeed, although injury to these bones is frequently followed by caries or necrosis, still the relation of either, in point of time, to the injury, is so remote that the history of contusion is commonly vague, or entirely lost. The injuries which determine these diseases are usually limited and often trivial bruises, which take an exaggerated effect in subjects of weakly or of strumous habit, circumstances which still further remove these abscesses from association with ordinary contusions.

Pain, the chief symptom attendant on the injuries of this group, is commonly severe, and is aggravated by the movements of respiration, by coughing or sneezing, and by pressure, but it falls short in its characters of the pain which attends a fractured rib. The diagnosis lies between simple contusion and contusion complicated by fracture. In ordinary cases, during the first few days which succeed the injury, the character of the pain alone serves to distinguish the simple from the complicated contusion. In both, the pain is aggravated by motion and by pressure, but the presence of a fracture renders it so acute and sudden that the patient cannot be induced to cough,

and shrinks with so sudden and characteristic an expression of suffering when the seat of fracture is pressed, or any movement of the trunk attempted, that the surgeon familiar with these injuries hardly needs to search for the physical signs of fracture. The pain of simple contusion of the chest-wall, and that which accompanies fracture of the ribs, though different in character in these injuries, is in both superficial, a feature which may serve to distinguish it from the deep-seated pain of lacerated or contused lungs. In both contusion of the chest-wall and contusion complicated by fracture, the progress is, as far as this symptom is concerned, similar, provided that no intra-thoracic inflammation or other accident occurs to alter the usual course of such cases toward recovery. The pain gradually loses its acuteness, more rapidly in simple contusion than where fracture is present, and about the tenth day ceases to attract attention. These characters of pain are necessarily ill defined in incomplete fracture of the ribs, a lesion which, in the living, can hardly be distinguished from simple contusion; again, in fractures of the costal cartilages the pain is less marked and less characteristic than that which attends fractures of the bones.

The *attitude* of patients suffering from either of these injuries, as they lie in bed, is, in the earlier days of their progress, most characteristic, and is the direct result of the effort to avoid pain; such patients lie commonly on the back, inclined to the injured side just so far as to set the sound side free without bringing the weight of the body to press on the seat of injury. This attitude is most marked in cases of fracture.

The *treatment* of simple contusion, and of contusion complicated by fracture of the rib or costal cartilage, without injury of the pleura or thoracic viscera, is to be conducted on the same principle—the enforcement of rest, and, if need be, compression of the chest-wall, such as shall limit its motions, either by bandages embracing the entire circumference, or by straps of adhesive plaster drawn tightly over the seat of injury. In simple contusion, complicated only by ecchymosis, pressure may be replaced by lotions compounded with drugs such as are accredited with the power of promoting absorption of effused blood. The guide in selecting the kind of remedy is the expression of the patient's feeling: if pressure be agreeable, it is to be adopted, to be abandoned again if disagreeable; only in contusion complicated by fracture of the costal cartilages, as seen in limited injuries of the chest, does pressure require to be applied with exceptional care and exactness; for very visible and palpable deformity usually attends these fractures, in consequence of the overlapping of the fragments of the broken cartilages—a deformity difficult to overcome, and, if suffered to become permanent, likely to be an opprobrium to surgical skill; beyond this it does not appear to entail any disadvantage.¹

CONTUSIONS INVOLVING THE THORACIC VISCERA.—The second group, contusions of the viscera without wound of the walls of the chest, contains a series of injuries of the highest importance, both in consequence of the risks to life which they entail, and on account of the difficulties which they present in the way of exact diagnosis.

In the cases of this group which occur most frequently, a direct blow breaks one or two ribs, or more, where it strikes; the force reaching further, drives the fragments of the broken bones inwards, causing, in the least degree, laceration of the parietal layer only of the pleural membrane, with probably slight bruising of the surface of the lung, but falling short of any laceration of the visceral layer of the pleura.

¹ The detailed examination of fractures of the bones and cartilages of the chest, will be found in the article on fractures.

In severer cases, a force acting with still more continued energy breaks the ribs, and drives the fragments, as in the preceding class, through the external layer of the pleura, and further on into the tissue of the lung: in such injuries a larger area of the chest-wall is crushed, and a greater number of ribs are broken; in post-mortem examination of such cases, not uncommonly the lung is found to carry the impress of the fracture of each broken rib, in a lacerated wound corresponding to the extremities of the depressed fragments all along the line of the injury, the wounds being, however, inflicted on the lung by only one fragment, anterior or posterior, at each seat of fracture, and all by the fragments on the same side of the line. In such injuries, as, for instance, where a cart-wheel passes over the chest and breaks the bones by direct violence, the line of maximum pressure and the direction of its plane may often be inferred, after death, from the arrangement of the wounds of the lung. This may be of importance, as the resiliency of the ribs is such that we do not find their fragments, excepting in very exceptional circumstances, retained in their displaced position as fragments of bone are prone to be in other regions, notably in the skull. In this kind of injury, as the result of the shape of the chest, the number of ribs broken on one side of the body is commonly less than the entire twelve, because the force is rarely so applied as to involve all, and at the top of the row, the clavicle and scapula shield the ribs.

The signs which indicate the existence of lesions of this class, either the least or most severe, vary materially according as the pleural cavity is normal previous to the occurrence of the accident, or has been obliterated in part or entirely by adhesion; a contingency so frequent that it must be taken into account in forming a correct diagnosis. If the cavity be normal, even the most limited wound of the parietal pleura by a fractured rib, gives rise in a short time to a localized traumatic pleuritis, which, although of little risk to the patient if he be otherwise healthy, adds much to his sufferings while it is active, and, under unfavorable conditions, may cause grave trouble.

If adhesions be present at the seat of rupture, this risk is avoided. In the graver injuries, where the ends of the fragments penetrate the lung, the escape of air and of blood into the pleural cavity is facilitated by the normal condition of the cavity, and the risks of pneumo-thorax and of hæmo-thorax are added, while their occurrence points to the diagnosis of the injury. On the other hand, emphysema of the areolar tissue (the result of the escape of air from the lung into its meshes), originating at the seat of contusion, is facilitated by the existence of adhesions; its occurrence in this position without a previous pneumo-thorax is rendered possible; and lastly, as the most trivial laceration may give rise to it when adhesions exist, its gravity as a symptom of wounded lung is greatly diminished.

In considering the value of emphysema of the areolar tissue as a diagnostic sign in these injuries, which are without wound of the integuments, it must be borne in mind that attention must be paid to the place of origin of the emphysema, whether it arise at the seat of injury, the air passing into the areolar tissue external to the parietal pleura which has been torn by fractured bones or cartilages, or, on the other hand, whether it escape through the mediastinum, as indicated by its appearing first in the neck or in the epigastric region. In this mode of origin, the air may leave the pulmonary vesicles or bronchi by rupture of the parenchyma of the lung, entirely independent of any lesion of either layer of the pleural membrane. Commonly this occurrence of general emphysema—even when it reaches to the degree of distending all the subcutaneous tissue of the body—although in appearance, and to the patient's sensation, an alarming symptom, is not attended with serious danger, particularly if it be not associated with pneumo-thorax and if it originate

at the seat of fracture of the ribs. If associated with pneumo-thorax, as already mentioned, its presence may increase the embarrassment of respiration caused by the pressure exercised on the lung by the air distending the pleural cavity, but in the gravest fractures of the chest-wall, in fractures of many ribs and of the sternum combined, although emphysema may be present, it does not reach the extent which it attains in injuries of lesser importance, for in the extensive fractures the respiratory power is commonly so impaired that the injection of air into the areolar tissue is made with but feeble effort. The shock, too, attending these accidents adds an important factor to the depression of the power of respiration. For these reasons an excessive emphysema of the body is often endured with less risk to life than more moderate effusion.

The development of general emphysema, particularly when the escape of air takes place at the seat of the contusion, presents the greatest difficulty in the way of an accurate diagnosis by physical examination, for rarely is the examination made before enough air has escaped to mask all other auscultatory signs by its crepitus under pressure, while the percussion note is so modified that even to recognize with certainty the tympany of a pneumo-thorax is most difficult.

The prognosis in these injuries—contusions of the chest complicated by fractured ribs—when seen by the surgeon within a few hours of their occurrence, depends on a correct estimate of the degree of shock which attends them, of the amount of impairment in respiratory power, and of the number of bones broken. Attention to these points is certainly more necessary than a detailed inquiry into the question of whether the rib-fractures have been caused by direct or indirect violence—a question to which over-much importance is attached by many writers, who, in the study of fractures of the ribs, are led away too readily by the erroneous theory of Petit, that in fracture from indirect violence, the displacement of the fragments being outwards, the thoracic contents are less liable to injury than in fracture from direct violence, with its result, inward displacement.¹ Where many ribs are broken on one or both sides, with or without fracture or dislocation of the sternum or cartilages of the ribs, death takes place almost immediately if there be rupture of the larger vessels. Escaping this rapid death, though small hemorrhages take place at many points, commonly the amount of blood lost is insufficient to cause death; in such cases the patient dies in a few hours, it may be with moderate emphysema of the areolar tissue, lingering with a death-like pallor and feeble breathing, with a falling temperature and cold breath, too depressed to feel, or, at all events, to complain of, much pain. On the other hand, when patients who have suffered serious chest-injury are able to give loud expression of suffering, we commonly find the associated symptoms less grave, the shock moderate, and but little evidence of blood-effusion, even though there be distinct evidence of wound of the lung. In such, the risks are those consequent on reaction, inflammation of the pleura and pericardium, and of the lung. Though undoubtedly a rare termination, even gangrene of the lung may follow such an injury.²

Injuries of this class, when seated in the lower parts of the chest, are most liable to be complicated by abdominal lesions, particularly rupture of the liver and of the kidney. Of these the former is the more grave, and, unfortunately, that least capable of recognition, until revealed by post-mortem examination. The complication of lacerated kidney, indicated by hæmaturia,

¹ Bennett, Fractures of the Ribs, an Examination of the Theory of Petit. Dublin Journal of Medical Science, Nov. 1878.

² Defontaine, Bulletin Médical du Nord, t. xix. p. 248.

though sometimes serious, is yet often attended with but little risk. Occasionally it becomes a remote source of danger by giving rise to perinephritic abscess, a disease which, should it follow, may delay its development for many months, being at first obscure and ill defined in its characters, and perhaps only revealing its existence by a sudden and unexpected rupture into the peritoneum.

Rupture of Viscera without Fracture.—The injuries of the thorax which possess the highest interest in view of the difficulties attaching to the explanation of their details, are the contusions of the viscera with laceration of their structure, which take place without fracture of the bony cage of the thorax. In many of the examples of these lesions, the subjects have been children, even mere infants, in whose bodies the flexibility and elasticity of the chest-wall is such that it is easier to comprehend the occurrence of laceration of the lung without fracture of the bones, than in the adult. Such are the earliest recorded cases, those of Ambrose Paré and Morgagni. There are, however, abundant examples which establish, on incontrovertible evidence, the fact that such lacerations are not the exclusive property of infancy, or even of early youth. [The Editor has tabulated¹ 30 cases of this kind, with 19 deaths and 11 recoveries.]

Writers on military surgery all admit the frequency of such injuries in the field, involving the lungs, heart, and great vessels, without wound or fracture. No less than twenty-five cases are reported in the Medical and Surgical History of the War of the Rebellion, which are referable to this group; in these we find the age of the patients recorded in seven cases, giving twenty-six years as the average. To many of these cases the term concussion is applied—a term which some writers have applied to all the injuries of this group, and which would appear to have been often used with the idea of establishing an analogy between the injuries of the chest and those of the head. I have already noticed, in excluding them from the scope of this article, the injuries of the spinal segment of the thoracic wall as alone liable to produce damage by concussion. As far as my experience goes, the heart is the only thoracic viscus which appears to suffer from concussion in any manner analogous to the brain. I am well aware that there is good reason to conclude that in most examples of concussion of the brain and spinal cord, structural lesions exist, and that so the term concussion most often implies an injury which escapes discovery through our ignorance in the art of reading symptoms aright, and sometimes the form of injury which is most temporary and repairable. Still, cases are recorded which force us to admit the possibility of concussion which will arrest for a time, or forever, the function of the nervous system, without appreciable lesion of the tissue of the organs. Similarly, among the recorded concussions of the thorax, we have at least one undisputed account of fatal injury, recorded by most competent authority, which presented no anatomical lesion. Nélaton,² who records this fact, observed by himself, attaches to it its proper value: "We confine ourselves to the simple statement of the fact, which is entirely exceptional and perhaps unique." The record is as follows:—

A porter was dragging a small, heavy-laden truck, when the strap broke; his body was consequently thrown violently on the ground, the front of the chest bearing all the force of the shock. In a few moments he was dead, and the autopsy revealed nothing beyond a superficial contusion of the anterior wall of the chest, without any alteration of the thoracic organs.

¹ Principles and Practice of Surgery, 3d edit., page 365. Philadelphia, 1882.

² Pathologie Externe, t. iii. p. 493.

I have seen an injury in which a state approaching fatal syncope followed on a fall from a car, the subject lighting directly on the precordial region, which revealed, on reaction being established, no physical sign, nor any symptom of pulmonary or cardiac lesion, either on the day of the injury or subsequently. Yet the collapse and failure of the circulation was, for a time, so profound and progressive, and of such duration, that it was feared that an intra-thoracic hemorrhage was taking place, and would necessarily prove fatal. Such cases may be regarded as examples of concussion, disturbing the functions of the cardiac ganglia and plexus of the sympathetic, and as such corresponding to the cases of fatal concussion of the semilunar ganglia and solar plexus of the abdomen. Admitting, then, the possibility of concussion of the thorax as a grave or even fatal injury, I desire to avoid the error of describing, as cases of concussion, injuries which either a more complete physical examination during life, or post-mortem inspection, would prove to be contusions of the pleura, or lung, or heart, accompanied with lacerations of the structure of those organs. To return to the subject of contusion of the lungs and pleura without fracture of the ribs,¹ a contusion of the chest which has neither marked the skin nor broken the bones, and which has failed to yield any sign of injury of the lung, may develop a rapid pleuritis, terminating in effusion. The following is a case in point:—

A sailor, aged twenty-four, was admitted into Sir P. Dun's Hospital on December 9, 1867; he was a young man of strong build, and his health had been uninterruptedly good until two days before his admission, when he sustained a severe fall on his back, on board ship. He fell from some considerable height in the rigging on to the deck. Not many hours after the receipt of the injury, he experienced a severe pain and soreness of the right side; he had rigors, followed by some amount of pyrexia. On admission, the symptoms were by no means urgent; there was slight cough, with soreness and sense of general uneasiness, but no dyspnoea. The soreness and inability to move were such as to lead to the diagnosis of an ordinary contusion, without intra-thoracic lesion or fracture of the ribs. Presently the phenomena of a rapidly developing pleural effusion were observed, which increased, in spite of treatment, until, by the ninth day, it filled the entire left side. On this day the left side was dull over its entire extent, both anteriorly and posteriorly, but the dulness did not transgress the median line. The hollows of the intercostal spaces were obliterated, and the respiratory murmur was absent from base to apex. There was no vocal fremitus, and the side was perfectly motionless. The heart was displaced towards the right side, its impulse being perceptible, and its sounds audible, in the middle line. There was puerile respiration on the right side. Pulse, 104; temperature, 103.6° F.; respiration only 24. 10th day. Pulse, 106; respiration, 28; temperature, 101.5° F. Complete dextro-cardia; impulse of the heart, one inch to the right of the sternum. Right side, circumference 17½ inches; left, 18. On the 11th and 12th days all these symptoms were more advanced, while bronchial rales were audible over the right lung, with increasing dyspnoea. The left pleural cavity was punctured, and forty ounces of clear, straw-colored serum were withdrawn. The relief was immediate; next day the pulse had fallen to 72, and the breathing to 24. An uninterrupted and rapid recovery followed.

In this case there was no ascertainable lesion in either the chest-wall or lung, and, as the character of the fluid drawn by the trocar would seem to prove, not even a trace of blood-effusion in the pleural cavity. Yet some damage to the pleura must have existed, and a large area of the membrane have been involved, else the sudden and rapid effusion could scarcely have arisen in a young and healthy man, whose good physical condition appeared established by the extreme rapidity of his recovery on the abstraction of the effused fluid.

¹ A long list of authorities may be quoted on this subject, dating back to Paré's case (1582):—Morgagni, Rouppe, Portal, Boyer, Hewson, Laënnec, Hérvez, Roques, Jobert, Dupuytren, R. W. Smith, Saussier, Gosselin, Otis, Coindet, Courtois, and others.

In the next degree of injury, contusion of the lung occurs with effusion of blood into the parenchyma of the lung, and possibly into the air-cells near the pleural surface; but when these conditions exist alone, they in most cases escape diagnosis during life. In the dead body, when other causes have proved fatal, it is not uncommon to find limited blood-extravasations in the tissue of the lung beneath an unbroken pleura, the result of direct or indirect injury.

In graver injuries, blood may be effused in quantity sufficiently large beneath the unbroken pleura, into a lacerated pulmonary parenchyma, to give an appearance, when seen shortly after the injury, somewhat similar to pulmonary apoplexy, or, should the patient live, to yield many of the signs of circumscribed pneumonia, combined with those of a vomica. Indeed, in practice, the phenomenon that indicates such a lesion is the occurrence of sputa not unlike those of pneumonia, appearing a few days after a chest-injury has been inflicted, without the constitutional disturbance of that disease, in a case in fact otherwise progressing favorably. Such a complication attracts attention, and a careful and minute examination detects an area of dulness, of crepitation, and it may be of metallic sounds, such as a cavity yields. Here the disintegration of a blood-clot yields the color to the sputa, and but for its appearance the complication might go unobserved, and the patient be none the worse for the neglect. In these injuries, and even in extensive pulmonary ruptures produced by contusion or by fractured ribs, the coughing up of blood immediately, as in penetrating wounds, is comparatively rare, probably because the injuries are usually inflicted on the external surface of the lung, and remote from the larger bronchi.

In this variety of injury, the pleura being unbroken, there may yet be emphysema of areolar tissue, originating either in the root of the neck or in the epigastric region, the air passing through the root of the lung into the mediastinum, and so reaching upwards or downwards. In injuries of a more advanced type, where the lung and its envelope are freely torn, the rationale of the process, when the ribs or sternum are unbroken, is not quite easily given. Writers, dating from Smith and Gosselin, have offered two explanations: to the earlier we have already referred—namely, the analogy supposed to exist between the lacerations of the brain without fracture of the skull, which are so often seen in so-called cases of concussion, and the lacerations of thoracic viscera. Gosselin, who is followed by more modern writers—Courtois, Follin, and others—rejects this theory, and seemingly on good grounds, viz., the total want of correspondence between the structures of the containing walls of the cavities and of their contents. Rejecting this theory, Gosselin holds that the ruptures of the lungs are, in these cases, direct or indirect, at the seat of the blow or remote from it; and that the condition necessary for either to occur is the closure of the glottis during the period of concussion; in this state the air, being inclosed in the thorax, when suddenly compressed bursts the lung and its envelope, as one may burst an inflated paper bag between the hands. A difficulty arises in accepting this theory, when we consider that the supporters of it range contusions of the lung without fracture in a progressive series, admitting the direct action of the contusion as a force competent to produce the lesser injuries, while to explain the greater lesions of the same group, the occluded glottis is introduced as a new element in the combination of conditions. The experiment of Courtois—the removal of the lungs and trachea from the body, and striking them while the trachea is closed or open—adds but little weight to the theory, for under such circumstances the anatomical surroundings are all changed, and the laws which govern the paper bag, inflated or open, are alone those which apply. A greater difficulty arises when we study the corresponding lesions of the heart

and pericardium. Here the explanation of the paper bag, however suitable it may be to the lung—and we do not seek to undervalue its importance—fails, for the gravest laceration of these organs may occur without the chest-wall being broken; even the heart may thus be torn away from all its connections.

The heart and pericardium contain no air, free to escape, or confined, which can be called in to explain, or help in explaining, the rupture of their tissues. The extreme degree of the rupture, observed in some accurately recorded cases of these lung-injuries, appears also to militate against the theory of rupture by air-compression. Again, adopting the theory of Gosselin, if the compression of the air in the lungs were the cause of the rupture, we should expect, if the closed glottis were the cause, that the opposite lung, or both, would be at some time or other found ruptured, but such an occurrence has not yet been recorded—always the rupture is placed somewhere in the lung of the side which has evidently been directly crushed. Smith, too, records the observation of an injury in the body of a dog, run over by a car, in which he says that the pericardium was extensively torn, as well as the lung ruptured; certainly the air could not have ruptured the pericardium. For these reasons, I confess that, much as I value the researches of Gosselin, I cannot accept his theory as complete any more than I do the concussion-theory of Smith. Difficult as it is to accept, I incline to the view that direct pressure, or traction, is the cause of these ruptures. Only such an explanation will apply to the corresponding lesions of the pericardium and heart, and we are forced to admit that the chest, even of the adult, can yield, though without fracture, under sudden strain and impulse, to allow of the infliction of such lacerations as have been recorded.

The symptoms of these injuries are more evident than those of the lesser degrees of contusion; briefly stated, they consist in the sudden development of pneumo-thorax, with the evidence of hemorrhage to a greater or less amount into the pleural cavity, and in some cases hæmoptysis, though this is noted by many as either absent or late in development. Although commonly fatal, we find records of some recoveries; death, in most cases, has taken place rapidly as the result of the bleeding into the pleura, and the compression of the lung by air and blood combined; with these, emphysema has often added to the embarrassment of breathing, and has hastened the fatal termination. While the physical signs and symptoms are mostly well marked, and developed immediately after the injury, there is at least one well-recorded example of their development being delayed for a long period, up to the fifth day:—

A young man, aged 24, admitted to hospital on February 15, 1864, had been knocked down by a heavy-laden cart, the wheel of which passed across his chest. Two hours after, on admission to hospital, his state was not such as to warrant the supposition that there was extensive rupture of any internal organ. The pulse, although rapid, was easily counted, the surface warm, countenance anxious, respiration short; he chiefly complained of his “belly” as the seat of injury, and the region of the liver appeared to be the most tender part. There was no evidence of fractured rib, and no hæmoptysis; he passed water freely, and it was of natural color; his spine was uninjured; on our proceeding to examine his chest, he smiled at the idea, as though he felt there was nothing wrong there, and putting his hand on the epigastrium, said, “oh, my belly! it is my belly!” Respiration was audible in both lungs at this time. On the following day his pulse was ninety, and full; he had quite rallied from the condition of collapse; he still complained of much pain over the liver and epigastrium. On the 18th (3d day) he became slightly, but decidedly, jaundiced; general condition as before; pulse ninety; urine deeply colored with bile, but containing neither sugar nor albumen. On the 20th he became suddenly worse; his breathing rapid and labored; pulse, 120–130, intermit-

ting; countenance much depressed; sweating profusely; dreadful pain in the epigastrium. On examination, the left side of the chest was found to be tympanitic, with respiratory murmur very feeble; the heart displaced to the right side of the sternum; and extensive dulness over the lower portion of the left side of the chest. There had been as yet no hæmoptysis, no trace of external emphysema, no audible metallic tinkling or amphoric resonance; neither did the ecchymosis described by Valentin exist in the lumbar region. On the 21st, in spite of the free administration of opium, his suffering was extreme; it was hardly possible to examine him, so incessant were his cries, "oh, my poor belly! open it and let the wind out."

As there was no doubt as to the fact that blood and air were pent up in the cavity of the left pleura, it was determined, in consultation, to relieve the patient by tapping. Just before proceeding to perform this operation, metallic tinkling and amphoric resonance were heard for the first time, leaving no doubt as to the existence of a wound of the lung. The trocar was introduced two inches external to the nipple; twenty-two and a half ounces of fluid blood (which afterwards coagulated firmly) were drawn off, besides a large quantity of air; the canula was retained in its place, guarded by a valve of membrane to prevent the ingress of air, but permitting the escape of fluid, which dropped away freely all day. The relief to the patient was complete; his pulse ceased to intermit, and he slept soundly. He became, however, gradually weaker, and died (the right lung being attacked by bronchitis) on the tenth day from that on which the injury was received.

At the post-mortem examination the heart was found displaced, and the mediastinum pushed over, while a considerable quantity of gas occupied the left pleural cavity; at least three quarts of blood were contained in the cavity of the left pleura also. The lung was lacerated in a terrible way, a large portion of it being nearly torn off, but no rib was broken. Some of the blood on the upper surface of the diaphragm had coagulated, but the greater part of it was quite fluid. It appeared as if a part of the lung had been adherent when rent off by the shock. The lung was collapsed and lying against the spine.¹

In this case the rupture was extreme, and the detached portion of the lung was adherent to the chest-wall; here, therefore, there was no necessity to call in an occluded glottis to explain the rent in the lung, the piece being evidently torn off, not burst asunder by compression of the air in the lung. It is hard to explain the delay of the development of the pneumo-thorax and of the hemorrhage into the pleura. The character of the observer precludes any doubt as to the accuracy of the record.

The mechanism of rupture occurring when a portion of the lung is adherent, is the same as that of ruptured pericardium, a tearing of a membrane or tissue under severe and sudden traction.

Ruptures of the heart and pericardium, as the result of contusions of the chest without external wound, occur most commonly as the direct result of fractures of the ribs or sternum, but ample records exist to establish the possibility of almost any kind or degree of rupture independent of fracture of the chest-wall. The most marked example, to which I have already referred, is thus reported by Casper,² in proof not only of the possibility of such injury occurring without fracture, but without marking of the surface of the body:—

Complete separation of the heart from its attachments is indubitably one of the rarest discoveries at an autopsy. A dealer in glass, aged 24, in crossing the heights of Spandau on a bitterly cold night in winter, had got off his wagon, heavily laden with boxes of glass, for the purpose of leading his horse down hill; the wagon, however, began to slide, and crushed the unfortunate man, unquestionably with the greatest violence, against one of the poplars which there border the highway; and there he

¹ McDonnell, Trans. Pathological Society of Dublin, vol. ii., N. S., 1864.

² Handbook of the Practice of Forensic Medicine, New Sydenham Society's Translation, vol. i. page 112. London, 1861.

was found, lying dead, that same night, by those who went to seek him immediately on the wagon entering Charlottenburg without a driver. With the most important internal injuries here, there was externally visible nothing save a trifling abrasion of the cuticle over the right cheek bone, and a similar one on the left arm. Who could have suspected what was found internally? On and in the head there was nothing remarkable, only that the sinus transversalis was more than usually full of blood. On opening the spinal canal in the neck, about a quart of dark, fluid blood escaped. The spinous process of the first thoracic vertebra was broken off, and lay loose in the soft parts. The deep muscles of the back were ecchymosed down its whole length; the spinal marrow was uninjured. On opening the left thorax, about thirty ounces of dark fluid were found, but there was no heart in the usual position; on the contrary, it was lying loose on the bottom of the thoracic cavity, for the pericardium had been completely torn across, and the heart torn from the large bloodvessels. The terminations of the aorta and pulmonary artery could be clearly made out; the substance of the heart was tense and firm, and both sides, particularly the ventricles, contained much dark, coagulated blood. The left lung was also torn almost across at its middle division, and, finally, there was a laceration in the right lobe of the liver two inches long and half an inch deep, and yet nothing was perceptible on the body externally.

This is perhaps the most extreme case of rupture of the pericardium and of the heart on record, and no fracture of the chest-wall existed, beyond a detachment of the spinous process of a dorsal vertebra, caused by the resistance of the structure against which the body was pressed. We have already referred to its importance as bearing on Gosselin's theory of rupture of the lung. The commonest cause of rupture of the pericardium and heart, as one would *a priori* conclude, is contusion of the chest with fracture of the bones, but a large number of the cases collected by Fischer¹ are examples of rupture without fracture of the bone, 32 to 44 being the proportion. While rupture of the heart and pericardium occur commonly together, in either of these injuries, the heart alone may be the seat of lesion, or the pericardium; among the seventy-six cases referred to, the separate lesions were observed each in five instances. "In all the cases of rupture of the pericardium without lesion of the heart, the rent has been of large size, and has been accompanied by fractures of the ribs and sternum." Such is the assertion of Follin, based on the reports of Fischer and others. I have myself observed an exception to the latter portion of his statement:—

A man, aged 22, a painter, fell on his left shoulder and head, from a height of thirty feet; he died in less than two hours, from the head-injury. There existed a blood-extravasation upon the sternum, and in the middle line of the neck at its lower part. The right lung, otherwise healthy, was deeply bruised, and the pericardium on the right side, where the pleura covers it in front of the root of the lung, was torn vertically, the rent being large enough to admit the hand, which passed into the pericardial cavity behind the phrenic nerve. The heart had a considerable superficial bruise at its base, but no rupture.²

A similar case, though from a different cause—the blow of the wadding of a small cannon—where in a healthy young man the heart completely burst the pericardium, without injury to the chest-wall, is recorded by Bonetus.³

The facts establishing the possibility of recovery after these injuries, are too few and far between to admit of any general conclusion being drawn from them. There exist the records of supposed dislocation of the heart, of Stokes, and a few others, where life has been prolonged, but the published observations of such cases are too imperfect to prevent the general conclu-

¹ Ueber die Wunden des Herzens und des Herzbeutels. Archiv f. klin. Chir. 1868.

² Bennett, Dublin Journal of Medical Science, vol. lxxviii. 1879.

³ Sepulchret. lib. iv. sect. 3, obs. 27.

sion that these injuries are mortal: in fact, if the recorded cases be exceptions to the rule, they are only just sufficient to prove that rule.

Ruptures of the diaphragm occur as the result of contusions alike of the chest and abdomen, and give rise to the grave complication of hernial protrusion of the abdominal contents into the thorax. Diaphragmatic herniæ are, indeed, more frequently the result of penetrating wounds of the chest, than of contusions without wound, but a sufficient number of the cases on record belong to the latter group to make it a matter of indifference in which connection we study the complication.

The simplest in its mechanism, but by no means the most common of these ruptures, is the laceration of the diaphragm by a fractured rib, as part of a grave injury of the lower part of the thorax. On the occurrence of the rupture, a portion of intestine, or in cases of large rents the stomach and intestines, enter the thorax, and in some cases—those of more limited rupture—immediate strangulation takes place, and so the fatal issue becomes determined; in others—those of larger rent—great embarrassment of breathing with vomiting ensues. The patients in such cases, while they run great risk of speedy death, not infrequently recover, the hernia remaining permanent. In these ruptures of the diaphragm, and in wounds by penetrating weapons or bullets, should the patient survive, the same result has been observed in all instances as far as the lesion of the diaphragm is concerned—the failure of union in its wound, a failure that must sooner or later lead to hernia if this complication does not establish itself at the moment of the injury.

The subject of these injuries of the diaphragm has hitherto fallen more into the hands of medical jurists, than into those of practical surgeons. The best descriptions and collections of cases are those of writers on the medico-legal bearings of the condition—Reid and Devergie—except perhaps the short chapter of Sir A. Cooper. One thing is clear, that in reference to the diagnosis of diaphragmatic hernia, as occurring in practice, our records abound in post-mortem diagnoses. The physical signs and symptoms are indeed easily reduced to description on paper, but the complication, whether or not it has arisen independently of wound or injury, whether it be congenital or traumatic, has commonly escaped detection except by the hands of the pathologist.

As the result of the anatomical disposition of the viscera, the left side of the diaphragm and its crural opening are the most common seats of protrusion, although the right side has been also affected; the mechanical barrier presented by the liver appears to determine this order of frequency; the openings for the epigastric vessels, too, have given rise to idiopathic hernia into the mediastinum.¹

The question of chiefest interest in these cases, based on what is discovered after death, and capable of being raised in the medico-legal consideration of a contusion or penetrating wound of the thorax, is that studied by Reid,² whether, such an hernia being found subsequent to an injury, it can be proved to have resulted from the injury directly, or whether its existence may be attributed to natural causes. On this point anatomy only can give satisfactory evidence: if the hernia be contained in a true hernial sac, its idiopathic origin may be affirmed; an uncertainty exists as to congenital herniæ, for these may or may not possess a sac, many, indeed most, wanting it; trau-

¹ Little, Dublin Journal of Medical Science, vol. lxvi. 1878.

² Physiological Researches.

matic herniæ have no sac. Baudens and subsequently Guthrie advocated operative measures for the relief of strangulation in these herniæ, occurring as a complication of wounds of the thorax, but the success of active treatment remains to be proved: conditions will readily occur to the mind of any practical surgeon, which, being recognized, might be made the subject of treatment, successful at least in averting death by strangulation of the intestine; but the difficulty of rightly appreciating the particular symptoms in the midst of the general disturbance following on either contusions or penetrating wounds of the chest, has hitherto, as has been said, relegated the cases which have not of themselves ended in recovery, to the doubtful benefit of a post-mortem diagnosis. There is ample evidence to prove that, short of the occurrence of intestinal strangulation, these herniæ are capable of prolonged existence without direct risk to life, so that a study of their various histories does not incline me to advocate a hasty abandonment of expectant treatment, even should the surgeon be fortunate enough to arrive at a correct diagnosis. As wounds of the diaphragm fail to unite, and remain permanently open, the extension of the opening by an operation could only add to the risks by causing further increase of the hernia. If the operation is to be undertaken, some means must be devised to obtain closure of the opening in the diaphragm. In the conditions arising from a recent grave wound of the thorax and abdomen, it seems hardly probable that success could follow an operation which would necessarily be, if its details should ever be worked out, most difficult in execution and most prolonged.

WOUNDS OF THE CHEST.

NON-PENETRATING WOUNDS.—Wounds of the thorax are classified as, first, superficial, involving only the parietes external to the pleural membrane; and, secondly, penetrating. The contrast in the mortality attending these groups respectively, is such that, in studying them, attention becomes instinctively fixed on the graver. The statistics of the last year of the American War of the Rebellion (1864–65), exhibit in the fullest manner this contrast:—

Wounds of the thoracic parietes, 3970.	Deaths, 54.
Penetrating wounds of the chest, 3203.	“ 1070.

Again, of the entire number of gunshot flesh wounds recorded during the war, 11,549, one hundred and thirteen died, but in these—

Death was not always due to the immediate or even remote effects of the injury. Fifteen fatal cases of pyæmia, five of tetanus, eleven of hospital gangrene, eleven of hemorrhage, one of erysipelas, and nine of pulmonary complications—including six cases of pneumonia, two of hydrothorax, and one of empyema—in these fifty-two cases, the injury and death were doubtless directly connected as cause and effect; of fifty cases, in which the fatal issue was referred to diarrhoea and dysentery in nineteen cases, to typhoid fever in twelve, to exhaustion in fifteen, to consumption in two, to anæmia and anasarca in two, it is difficult to determine what relation, if any, existed between the injuries and deaths. Finally, in eleven cases—two of malarial fever, two of cerebritis, one of peritonitis, one of diphtheria, and five of smallpox—it is fair to conclude that the original injuries were less closely connected with the fatal results than were hospitalism and other morbid causes. It appears then, that in uncomplicated, superficial gunshot wounds of the soft coverings of the chest, the mortality is exceedingly small. They commonly cause but little pain, and seldom interfere with the exploration of the lungs by auscultation. They have the disadvantage, however, of healing very slowly, especially when they produce a long groove or canal, or a fistulous track beneath the skin or through the muscles, forming what the French denominate *plaies en sêton*.

Their tedious cicatrization is doubtless due to the want of that absolute rest and immobility requisite for prompt reparation.¹

When we consider that these remarks are based on the observation of gunshot wounds—not incised, nor even lacerated or punctured wounds—the estimate of gravity falls still lower, for no wound equals in its risks, no matter how trivial it may be, the gunshot. We may therefore take the injuries referred to in the sentences above quoted, as of the worst of their kind; but what a small list of deaths, and how many of them absolutely remote in causation from the wound. In civil practice nothing is seen to change the aspect which the military picture presents; incisions on the thorax do as well as elsewhere, and we rarely see the *plaies en sêton* as a result either of accidental or of intentional wound.

The question next in importance, after this short examination of superficial wounds of the chest, leads us on directly to the subject of penetrating wounds. The treatment of the superficial injuries, if we exclude, as is best done at present, the wounds of the axilla and root of the neck, need not delay us, for the ordinary principles of surgery apply, and no exceptional difficulty presents itself in carrying out their details.

PENETRATING WOUNDS OF THE CHEST.—In passing on to penetrating wounds, it does not seem necessary to examine the question of their mechanism, as in the case of contusions, for every one can work out the problem who knows the relations and structure of the viscera, and who understands the essential characters of the kinds of wound inflicted either by cut or stab, or by gunshot injury.

What are the characters that distinguish penetrating from superficial wounds? The kind and direction of the external wound or wounds, difficulty of breathing, hæmoptysis, emphysema, passage of air through the wound, the escape of mingled air and blood from the wound, and, at a later period, pneumonia.

It is evident that, under exceptional conditions, the *kind and direction of the wound* alone may suffice for exact diagnosis: if, for instance, a sword or bayonet has transfixed the chest from before, or laterally, so that the straight line connecting its hilt and point, or the corresponding orifices, must traverse the lung, then no doubt need exist; but such a conclusion may not be drawn from the observation of bullet-injuries, unless indeed the quality and speed of the projectile be accurately known, for the deflection of bullets is a familiar fact. Remove the evidence afforded by an orifice of egress, of either bayonet or bullet, and at once the range of uncertainty increases so that the highest degree of doubt may exist as to the direction and depth of the wound.

Even the existence of two openings is but equivocal evidence that a bullet has passed through and through, for this condition may result from two bullets, neither of which may have entered the cavity.

Difficulty of breathing, Fraser² tells us, “is most fallacious as a sign of chest-wound; it may be most intense from moral or other causes, when the lung is not wounded, and it may be altogether absent, when the lung is seriously implicated.” In thirty cases of proven wound of the lung, dyspnœa was noted as absent in twenty-two. Not only may there be no dyspnœa at first, but there may be an almost complete immunity from shock.

Hæmoptysis in the same group of cases was wanting in twenty-three, although it has been regarded as most constant by some writers. I have

¹ Med. and Surg. Hist. of the War of the Rebellion, Part First, Surgical Volume, page 472.

² Treatise upon Penetrating Wounds of the Chest, page 45. London, 1859.

already noted the rarity of its appearance in lacerations of the lung without external wound.

Again, in these thirty cases, *emphysema* was present but five times, a fact resulting, as Dr. Fraser states, from the injuries having been bullet-wounds, not stabs, for in the latter—in modern warfare, a comparatively rare injury—*emphysema* is most constant. Its presence in the areolar tissue around a punctured wound does not necessarily imply that the lung is wounded, it may result from the introduction of air into the pleural cavity, the lung escaping any injury, or it may occur in certain superficial injuries without even a wound reaching beyond the superficial muscles. I have seen, for instance, well-marked *emphysema* around a punctured wound, extending for some distance through the muscular planes where the injury occurred, thus:—

A boy climbing over an iron railing armed with spikes above, slipped in turning over the spikes; he fell, and his clothes and skin catching on the spikes, he was suspended; the spike supporting him entered the posterior fold of the axilla, low down on the chest, and his weight was for a few moments borne by the skin and the *latissimus dorsi* muscle, with his clothes; he was lifted off by a passer-by, and carried to hospital, when there was found a small wound with *emphysema* all around and extending beneath the muscle. A couple of days cleared away the indrawn air, and no trace or symptom of wound of the chest-cavity or lung impeded recovery.

Returning to the group of cases above quoted, we find the *passage of air through the wound* present in only seven instances. It would appear, then, that each one of these cardinal symptoms of penetrating wound may be wanting, and, further, that each in its turn is more frequently absent than present; on what then are we to rely for diagnosis?

I would desire to say that, although I would not place implicit reliance on any one of the heretofore accepted signs of lung-wound, if there were three or more of them present, I should consider their concurrence as strong presumptive proofs of lung-wound. To these add a weak pulse, a cold and clammy skin, orthopnoea with effusion of blood—now easily diagnosed by aid of percussion and the stethoscope—and the presence of ecchymosis of blood in the loins (but which I never witnessed, although it is dwelt upon as a certain evidence of effusion into the pleural cavity, by Valentin and others); with all these, or the majority, it may be considered as nearly certain that the substance of the lung has been wounded.¹

Dr. Fraser's table of cases, of which I have quoted the essential details, supports with the incontrovertible argument of accurately observed facts, his assertions which I have copied. In this may be seen repeated the observation of all exact observers in every branch of medicine, that unqualified reliance cannot be placed on any particular symptom. Nay, even the testimony of two witnesses is insufficient; the whole statute must be fulfilled, and the concurrence of three only can be admitted to be incontrovertible.

The difficulty that seems to be present to the mind of most writers on penetrating wounds, in establishing a correct basis for discussion of the subject, is the theory of collapse of the lung on opening the pleural cavity. It must be borne in mind that the estimate of pulmonary collapse is derived from a very fallacious test, the observation of the phenomenon in the dead body—or rather from an over-estimate of the tendency and amount of the elastic retraction of the lung on the admission of air. The condition of the lung in the living and dead is widely different; in the living, a heated air fills the air-cavities, and the lung-vessels are full of blood exposed to active pressure from the right ventricle of the heart; in the dead, these conditions

¹ Fraser, op. cit., page 87.

are reversed, and therefore the lung's power of suddenly retracting on its root must be much less active in the living than in the dead body; and at best, in the dead body, retraction is but moderate, and either a pneumonic swelling or permanent vascular emphysema will suppress it. While I do not for a moment deny that air, or fluid, will readily enter the pleural cavity and accumulate there while the lung retracts under the pressure to its root, I do not see that the elastic traction of the lung towards its root makes the pleural cavity so greedy for air that every wound of the pleura must necessarily lead to pneumo-thorax; even the exertion of respiratory expansion does not appear so certain to cause this influx into the pleural cavity, either in the case of wound of the pulmonary pleura only—as in rupture of the lung without external wound—or in the more evident wound of the costal pleura from without.

In penetrating wounds which reach only as far as to divide the costal pleura, and more rarely in those that involve the surface of the lung, a *hernia of the lung* may take place as a rare complication, perhaps the rarest of the many attending these injuries. These herniæ are either primary or consecutive. The cases in which primary hernia of the lung has been observed are, first, those of limited and oblique wound, through which air is prevented from entering the pleural cavity by the obliquity, while the egress of the lung under the pressure of muscular effort or the strain of coughing is unopposed; second, cases of wound which permit the entrance of air, but forbid its escape—in these cases the lung escapes only at the moment of infliction of the wound; and third, cases of wound of large size, when the lung escapes at or very soon after the infliction of the injury.¹ It would appear from the records of the American war, that a complication, and possibly a cause, of the hernial protrusion has been, in some cases, the coincidence of a wound of the diaphragm and the escape of abdominal viscera into the pleural cavity, which, by increasing the contents of the thorax, has aided or compelled the protrusion of the lung. The occurrence of a wound of the lung, although it may not render the protrusion of the wounded viscus impossible, clearly opposes its occurrence, for the pressure of the air contained in the lungs and trachea must in a measure fail to act when such an opening exists, and the presence of a pneumo-thorax consequent on the wound tends directly to prevent a hernia by repressing the lung from the chest-wall. The second variety, consecutive hernia, takes place as a remote result of wound of the chest-wall, the tumor arising after the removal of fragments of broken ribs, and during or subsequent to cicatrization of the wound.

There is but a single instance of successful reduction of a traumatic pneumocele without previous ligation, the case of Angelo.² A good recovery ensued, though the lung-tissue was wounded. Authors generally advise taxis, and some recommend the enlargement of the wound to return the tumor; but there is no evidence of the expediency of this measure. Excision or ligation were employed in most of the cases, and no bad results appear to have followed these operations. Non-intervention is probably the safer precept. After a while the protrusion contracts adhesions with the walls of the thorax, and occludes the opening.³

It would appear by the report quoted, and by the accounts of recorded cases, that there remains a necessity for permanent support by a properly devised pad and bandage to keep the parts secure.

The questions of highest importance in the consideration of penetrating wounds of the chest, are those relating to *hemorrhage*, as a symptom and as

¹ Morel-Lavallée, Mémoires de la Société de Chirurgie de Paris, t. i.

² Gazzetta Medica di Milano, Feb. 1844.

³ Med. and Surg. History of the War of the Rebellion, Part First. Surgical Volume, p. 518.

the essential object of treatment. In contusions of the chest, too, hemorrhage is, as has been already noted, foremost in importance, but the conditions of those injuries place it more beyond the reach of surgical interference, while its external appearance is comparatively rare. Its total amount is apt to be either extreme, leading to an immediately fatal result, or else comparatively unimportant.

In penetrating wounds, while the same extremes exist, the intermediate degrees are innumerable. In addition, the symptoms are more evident, and the source, in some cases at least, sufficiently exposed for surgical treatment.

When the *pericardium* and *heart* or the *great vessels* are the parts involved by a penetrating wound, death is the immediate result in the vast majority of instances. Death may occur in two ways. In the first, a puncture or similar small wound, piercing the pericardium, opens the heart or a great vessel—aorta, pulmonary artery or vein, or vena cava—and the blood, issuing, fills the pericardium, compresses the heart, and kills before the total amount of blood lost is by its quantity sufficient to cause death. A wound in this way may be fatal without opening the heart-cavities or greater vessels, for, striking the coronary artery of the heart only, the fatal result has been brought about in the same way, but in a slightly longer time, a couple of hours; among the records of wounds of this class, inflicted by fine and sharp instruments, we read of lives prolonged for days, for weeks, even for years—but these are among the curiosities of medical literature, not within the category of cases which belong to practical surgery. The knowledge of their having occurred is, however, necessary for the surgeon, in order that he may not commit an error of over-statement in asserting that all wounds of the heart or great vessels must necessarily be fatal. The second mode of death in these injuries is by the sudden and free flow of blood into the pleural cavities or mediastinum; in such cases death takes place at once, or within a few minutes.

Passing from these cases, which are beyond the reach of surgical art, we come to the hemorrhages of more limited and controllable character, where the blood flows from vessels wounded in the parietes of the chest—*intercostal*, *internal mammary*—from the *phrenic*, or from the smaller vessels of the *lung*.

The symptoms which indicate these sources respectively, differ materially, but unfortunately are often so ill defined that an exact diagnosis is impossible; if direct surgical treatment is to avail anything under these circumstances, we cannot be too careful in the attempt to determine the exact source of hemorrhage.

The position of the wound in the chest-wall, intersecting the path of either the intercostal or the internal mammary vessel, and the flow from the wound of a stream of either arterial or venous blood, without hæmoptysis, while percussion reveals an accumulation of fluid in the pleura, form a group of symptoms that are easy to read, and in which the indications are clear; but such are seldom seen. If such were present, no surgeon could fail to seek the bleeding orifice, to dilate the wound if necessary by incision, and, failing to take the vessel by the forceps, tenaculum, or needle, to adopt some one of the many methods specially designed for the control of hemorrhage from these parts. In the exploration for the bleeding point, the position of the intercostal vessel in relation to the rib, placed under cover of its overhanging, inferior border, must be borne in mind. To verify the source from which the jet proceeds, pressure made by a finger in the wound, against the lower border of the rib, may determine the bleeding point or vessel (Boyer); or a gutter-shaped piece of card-board, carried sloping into the wound, may, by catching the blood flowing from above, prove its intercostal source, while a flow from beneath the gutter would point to the thoracic cavity as its origin (Richter). In con-

sidering the treatment of a bleeding intercostal or mammary vessel, it must be borne in mind that secondary hemorrhage has more often proved troublesome or fatal in wounds implicating these vessels, than primary bleeding, and that so a greater difficulty has been found in practice, in their case, than would be anticipated from the contemplation of their anatomical relations in the healthy condition. This observation applies to the surgery of all regions, but the difficulties presented by the position of these vessels within the bony cage of the thorax, and by their immediate relation to the cavities of the pleura and pericardium, to which the styptics applicable in corresponding hemorrhages in the limbs are ill suited, require for their treatment a high degree of skill and decision. It so happens that special methods for the management of these cases have been devised in extraordinary number, and perhaps each with merits which may recommend its adoption in some particular emergency. While the wounds which furnish either primary or secondary hemorrhage from these vessels, are at all times, even in warfare, rare, sufficient reason has been shown why, when they occur, the life of the sufferer is often to a great extent placed solely in the hands of the surgeon.

In these circumstances, I cannot help approving the just criticism of the editor of the *Surgical History of the American War*, on Guthrie and even Boyer, who, each, adopting whatever of these methods suited him or first suggested itself, sneers at all others, at least at all but his own, each thinking his own alone worth notice. It will at once appear to the practical surgeon that the diagnosis of the source of bleeding is more easily made in these cases under the conditions of secondary, than in those of primary hemorrhage, for bleeding from the wounded lung, though possible as a secondary event, is less likely than that attending the separation of sloughs of tissues directly related to broken bone, either sternum or rib. Therefore, although the identification of the source of bleeding has appeared in most cases to have been readily made, the prominent feature of the recorded cases is the difficulty of efficiently controlling the bleeding vessel, in consequence of its altered surroundings, and of the liability of the tissues, softened by disease, to separate too readily under pressure of the ligature or other means adopted. The methods of control are the direct ligature, by tenaculum or forceps, or torsion of the vessel (Guthrie); the including of rib and vessel, and a compress applied over the vessel, with the skin, by a needle carried around all (Girard); the more skilled application with a blunt needle, curved so as to pass around the rib, push aside the pleura, and be capable of introduction from the wound without injury of the skin (Goulard)—the blunt needle of the chain-saw may be used (Howard); complete section of the vessel, as in arteriotomy, with a compress (Assalini); digital pressure maintained by successive hands (Chelius); a compress secured with a thread, passed within the thorax and turned half around, to prevent its escape, and tied against an external support, as in plugging the nose; most generally approved of, yet it would seem but seldom tried, the compress of Desault—a piece of linen pushed within the wound while its edges are maintained without, and the recess so formed filled with padding, so that when the inclosing linen is drawn tight, the contents shall be drawn firmly against the circumference of the wound, pressing thus from within against it; and steel and ivory clips for compression of the rib and vessel, instruments probably efficient though cumbersome, and certainly unlikely to be at hand in the exceptional emergency of these hemorrhages. Finally, the intercostal might be tied at a point on the proximal side of the wound, in order to allow this to remain open and free from compresses. A smaller number of plans have been proposed for securing the *internal mammary* vessel, and various methods of incision have been suggested to expose the artery on the proximal side of the

wound. The fatality of hemorrhage from this vessel is very great, as is proven by the statistics collected by Günther (19 cases of wound, 9 ascertained cures, 2 probable cures, and 8 deaths). The rarity of detection of a wound of this vessel, and its fatality, are well shown by the records of the American war:—

Only five or six cases are found on the records in which wounds of the internal mammary vessel were distinctly recognized. Three of these were treated by compression and styptics, and two by ligation. But there are many other recorded instances of wounds near the edge of the sternum, with hemorrhage, yet without hæmoptysis, in some of which the existence of this lesion may fairly be suspected. As it was fatal in the five cases in which it was detected, it merits serious attention.

The operations on this vessel, practised in the third or upper intercostal spaces, by vertical, oblique, or transverse incisions, with or without the removal of a costal cartilage, have all been formulated, and present no great difficulty in the normal structure of the parts involved, though I can fully conceive that there might be the highest degree of difficulty in the conditions likely to be present in cases of secondary hemorrhage. But in practice these operations have most often failed, for the direct ligation or control of the bleeding point, or the inclusion, rather, of the bleeding orifice between two ligatures, is the only method to be relied on in case of a vessel so freely anastomosing along all its course with arteries of considerable size. It would appear, then, that the attempt should always be made to secure the vessel in the wound—if necessary, by removal of bone or cartilage.

The symptoms which in combination indicate that the lung has been involved in a penetrating wound of the chest are, dyspnoea, hæmoptysis, and a greater or less development of the phenomena of shock; there may, in addition, be evidence of the accumulation of air and of blood in the pleural cavity, and, it may be, the escape of blood and air from the wound with each act of expiration. When all or the greater number of these phenomena are present, there can be no doubt that the lung is wounded; but many, if not all, may be wanting or equivocal in degree, and yet the lung not have escaped, while, on the other hand, many may be present without the lung being involved. Shock and dyspnoea are the common property of both superficial and deep wounds of the chest, and even when present in a marked degree they do not afford reliable evidence of penetration of the lung.

Hæmoptysis, the most essential symptom, may be absent even in deep wounds of the lung, particularly in gunshot wounds and in injuries inflicted by blunt points; and the escape of air and blood externally from the wound, with the motions of breathing, and the evidence afforded by percussion and auscultation of their accumulation in the chest, are phenomena which are common to wounds which merely penetrate the pleural cavity, and to those in which the lung is implicated. In the absence or temporary suppression of these symptoms, the surgeon is strongly tempted to explore the wound by probe or finger, in order to determine its direction, and so complete the diagnosis. But the highest authorities have condemned this practice, and the records of military surgery are not wanting in evidence of the fact that such interference has been at once and evidently fatal. There is, too, ample proof that, in many cases, even when such exploration has been made by both probe and finger, only negative and fallacious conclusions have resulted. Far safer is it for the surgeon to be content to fear the worst and hope for the best, even at the sacrifice of reputation for skill and decision, rather than by a rash exploration to open up a cavity as yet uninvolved, or reprove an arrested hemorrhage. "If the surgeon is not too busy with his fingers or probe—too curious to know what will be of little use—the wound in the lung

may be united to the external wound, and nothing from the former can fall into the cavity of the pleura."¹

When a sharp instrument pierces the lung, even superficially, hemorrhage may be profuse; and in cases where any wound traverses the lung near its root, the amount of bleeding may be not only profuse but rapidly fatal. In those grave cases where the source of bleeding is beyond the direct control of the surgeon, where the powers of nature alone must be trusted to restrain the flow, what line of treatment is to be adopted? The coagulation of the blood in the wounded lung, and the compression of the lung by air, or blood, or both, in the pleural cavity, leading to the retraction of the lung, are, with rest, as far as it may be maintained, the only objects to be sought for.

On this subject, more than any other, surgical opinion and practice have changed in recent times. Here venesection lingered longest as the most efficient treatment; venesection, too, carried to the utmost degree, and repeated on every sign of recurrence of bleeding. Up to the time of the Crimean War (1854) this practice prevailed, and was taught in every manual and lecture.

We induce this fainting by bleeding, and here the bleeding from the arm must be large in quantity and suddenly drawn. The patient's friends may say: "He has already lost a large quantity of blood, and is still losing it; why, therefore, would you take more blood from him?" But do not be debarred from your purpose by anything that may be said or hinted by those who cannot understand your object. There is nothing else to save the patient's life. When you open a vein in one arm, if it does not bleed freely, don't hesitate to open a vein in the other; and you must not be satisfied with a small orifice, for ten ounces of blood taken suddenly will cause fainting, when it would take twenty ounces to produce the same effect if taken slowly. You save blood and the patient's strength in proportion to the freedom with which the blood flows from the vein. But suppose you succeed in lessening or stopping the flow of blood from the mouth, may you relax your vigilance? No, indeed, for in five or six hours it may break out afresh, and you should be on the spot to repeat your venesection instantly. It may return several times in six, ten, or twelve hours, and at each recurrence you must be ready with the lancet; even at every new fit of difficulty of respiration you will bleed, if possible—anything to arrest hemorrhage from the lungs.²

Such was the teaching forty years ago by a master of the art, and the prevalent practice, supported by the great military surgeons of his day, was exactly such as he describes. The change to the complete abandonment of the lancet was not long in coming around, and in the American war no longer is there any mention of bleeding to arrest hæmoptysis in penetrating wounds of the chest. The position of this question at the time of the Crimean war is well shown in the following record by Macleod. The case, too, displays fully the wish of the practical surgeon to treat the wound with a free exit for discharge, only restrained by the pressing emergency of the control of hemorrhage:—

Hannihan, a private in the Royal Irish regiment, was admitted into my wards in the general hospital on the 18th of June. While lying on the ground, with his head towards the enemy, he was struck above the left clavicle by a rifle ball, which traversed his lung from its summit to its base, and was found lying quite superficially in the left lumbar region, from which position it was removed. The dyspnea, on admission, was very great, and the hæmoptysis was profuse. The surface was cold, and bedewed with cold perspiration. The pulse was weak and tremulous, and the decubitus was on the wounded side. The removal of the ball was followed by a tremendous gush of blood from the incision made, and the blood continued to flow in such quantity that I had to close the wound to prevent immediate dissolution. The necessity of guarding

¹ Colles's Lectures, vol. i. page 215.

² Ibid., page 211.

against a suddenly fatal event was, for the moment, paramount to the indication of freeing the embarrassed lung from the effused blood, and as the hemorrhage, moreover, appeared to be active, I wished to try to check it by the pressure which would result from the blood being allowed to accumulate in the thoracic cavity. The patient was twice largely bled, and he had acetate of lead and opium given him. These measures appeared to afford him some relief. Next day he had rallied considerably. His pulse was better, and his look was less distressed. By the afternoon of that day the dyspnoea became so urgent that I allowed a considerable quantity of the collected blood to escape. This gave him for a time decided relief. The severe exhaustion which, however, soon followed this step, and the return of the dulness to its former level, seemed to intimate a renewal of the hemorrhage, hence I did not reopen the wound, but determined to abstain from all interference till the bleeding vessel had had time to close. The patient was so completely prostrated by the hemorrhage which had evidently taken place internally, that I could not have recourse to any further depletive measures. The stethoscopic examination of the chest discovered amphoric breathing over the upper part of the left lung, while over the whole surface of the right chest the respiration was harsh and loud. Dulness existed on the left side, from the base of the lung up to an inch and a quarter above the level of the nipple. There was suppression of urine for thirty hours after admission. This patient died on the fifth day without any change in his symptoms from those noted above. The left side of the thorax was found more than half full of blood, for the most part fluid. The lung was half solidified and compressed against the spine. Lymph was effused to a limited extent on its surface. The ball had traversed the lung in a direction from above downwards and backwards. Its track was ragged and coated with lymph. The three upper and the three lower ribs were fractured.

Here we have graphically told the cause, symptoms, and treatment of a gunshot injury of exceptional severity, implicating one lung, but just not severe enough to kill outright on the spot, or during the first few hours. An exact parallel in progress, the thoracic being exchanged for abdominal symptoms, might be readily found in the annals of penetrating wounds of the abdomen; a life on the brink of death for a few days, and death on the fifth; a case hopeless throughout, but giving just enough encouragement to the surgeon to induce him to hope even against a certainty. Can one in the face of these phenomena believe that free bleeding at the elbow will mitigate the symptoms of free bleeding into the thorax, or offer much hope for the control of this bleeding? Do not such bleedings as were practised here take away the only hope, as fast as the same loss from a central vessel would? These ideas seem to have forced themselves on the surgical mind at the time of the Crimean War, as we may see clearly in the records of this case, its reporter, as it were, halting between two opinions; as a few years more passed on, we find the treatment absolutely abandoned—possibly too absolutely; but if this latter extreme has been too completely reached, how much less damaging is the excess than that of the school which bled for every and all complaints, and with all the more vigor the more nearly death from hemorrhage had been already reached. Fraser expresses himself in doubt of the correctness of the practice at the time of the Crimean War, thus:—

Hemorrhage with the older and with many of the modern writers, is held to be a great source of danger in lung-wound, and in its arrestment the chief element of success is held to be venesection; to what extent this theory is correct remains to be proved.

It is worth noticing, in reference to this question, that free venesection has been advocated not only for the relief of actual hemorrhage, by inducing fainting, but also to relieve dyspnoea, as we see in the case quoted by Macleod; even further, it has been used as a prophylactic against the occurrence of pneu-

monia—objects sufficient in number at least to be accomplished by a single remedial measure, how ineffectual for each appears to be amply proved by Fraser's arguments, which first turned the tide of professional opinion into a more rational channel. The experience of wars subsequent to the Crimean, but chiefly that of the American Rebellion, has proved that now the tide sets entirely against venesection in the treatment of penetrating wounds of the chest. In its place, strict attention to the means of obtaining rest, with cold to the surface, and opium, are now the means of treatment.

A question of equal importance with that of general treatment is that of the local management of the wound. The great disturbing cause which seems to have led to uncertainty as to the mode of treatment to be adopted locally, is the fear that collapse of the lung will follow the entrance of air. We find, then, two distinct plans adopted in these cases: (1) the closure of the wound, even "hermetically," and (2) its opposite, allowing the wound to remain open under some suitable dressing. Which is the better? The vast majority of penetrating wounds are gunshot injuries; the exceptions, incised or punctured wounds. Applying the ordinary principles of surgery, even to the case of the exceptional group, nothing but absolute necessity would justify the complete closure of the wound; for all experience proves that, except in the case of such surfaces as those of the divided lip, or the like, accumulation of fluid in the deep part of the wound will take place. Even between the most skilfully cut flaps of an amputated limb, let fluid be pent up, even under the most perfect antiseptic management, its tension will lead to inflammation and local distress—it may be to pyæmia—if no vent be provided. Surely the conditions of a wounded lung and thorax are unfitted for the experiment of closure. We can imagine a clean sword-thrust, or the like, healing throughout, even when it has passed through the edge of the lung; but these wounds are admitted to be even more dangerous than gunshot injuries, from their tendency to bleed, and so to cause fluid accumulations if closed superficially. Nothing appears more repugnant to the principles of surgery than the attempt to close a bullet track, which, however it be placed, under its ordinary conditions, must afford ample material to be discharged externally.

The attempt¹ made to close the external wound by excision of its edges and suturing of the surfaces so formed (Howard), has been extensively tried; but although it has afforded relief at times, and has not always entailed the serious results that at first view one might expect, it has met with the fullest condemnation from those best placed for judging of its results—the surgeons of the American army. The fact of a bronchial drain existing from these wounds seems alone to provide for the relief of accumulation, when the wound is closed either by its form or artificially. Older authorities, Paré and those that followed him, fully appreciated the necessity of a drain from such wounds. Larrey broke in on their plan by the adoption of immediate closure, but his cases were examples of incised wound of the lung, and there existed further an active hemorrhage, calling for immediate pressure for its arrest. In these circumstances the closure adopted for the control of bleeding was found to give relief to the dyspnoea also; just in such cases at the present day would a similar treatment be adopted. But in the case of bullet-wounds, the consensus of opinion among military writers is that the least fatal injuries are lung-wounds in which the bullet passes clean through—less injurious than wounds inflicted by a lesser velocity, in which the bullet lodges. What are the elements of safety added by the second hole? The absence of the foreign body and the establishment of a better drain. Guthrie's observation is an apt illustration:—

¹ Med. and Surg. History of the War of the Rebellion, Part First, Surgical Volume, p. 497.

General Macdonald, of the Royal Artillery, was present at Buenos Ayres when a bombardier of that corps received a wound from a two-pound shot, which went completely through the right side, so that when led up to the general, who was lying on the ground, he saw the light quite through him, and supposed he was of course lost. This, however, did not follow, and some months afterwards the man walked into General (then Captain) Macdonald's room, so far recovered from injury as to be then able to undertake several parts of his duty before he was invalided; thus proving the advantage of a shot, however large, going through, rather than remaining in the chest.

It may be necessary, therefore, to close a wound, gunshot, incised, or punctured, to command hemorrhage or to relieve urgent dyspnoea, but under other conditions, particularly with gunshot wounds, a patulous orifice is best and most necessary. We find even Guthrie teaching the necessity of being on the alert, in the treatment of incised wounds, to tap, or relieve by counter-opening, on the earliest approach of distress from intra-thoracic accumulation.

The experience of the treatment of empyema, and of wounds in general, makes it very probable that when tested in the service of campaigns, where only a fair comparative estimate can be made, suitable antiseptic measures will be found (in spite of the unfavorable field for them which a bullet-wound of the chest offers) to confer great advantages, while their adoption need neither materially complicate the treatment, nor violate any established principle of surgery.

The annals of military surgery prove, what might *a priori* be asserted with confidence, that penetrating wounds of the thorax, involving both lungs, are almost absolutely fatal. Considering the mortality which attends penetrating wounds of one lung, we need not wonder at this fact. Just enough evidence exists to prove that recovery is not absolutely impossible; but the facts place such injuries only second in gravity to those of the heart and great vessels.

The immediate risks having been avoided in either of these injuries—wound of either or both lungs—there remains, where any hemorrhage has occurred into the pleural cavity (and this must be in all cases except where pre-existing adhesions prevent it), the question as to the behavior of such effusion, and as to its appropriate treatment. Almost as constant as the bleeding into the pleural cavity, is the escape of air from the wounded lung, or its introduction from without. Should the wound be small and oblique, as from the blade of a knife, or from the bullet of a small pistol, the external wound, even when direct, may fail to admit the air, and then the lung-wound is its only source. The risk is from the mixture of air and blood, a necessary result of these injuries, which may lead to the decomposition of the latter; where the air escapes from the lung into the areolar tissue, in fractures of the ribs, it is already by its passage over the bronchial surfaces so perfectly filtered that it appears to be invariably aseptic. In moderate hæmo-pneumo-thorax, originating by the same route, a similar immunity from putrefactive change exists; and, as the experience of operations for paracentesis, apart from the records of military campaigns, proves, even without antiseptic precautions, air, in moderate quantity, may sometimes enter and mingle with a serous effusion with impunity. The experience of practical surgeons with this accident has proved, however, that here the border-land between security and danger is reached: while escape from bad results is possible, even without either air-filter or antiseptic, still the risk is imminent. The multiplicity of devices invented to guard against the accidental introduction of air from without, in the operation for paracentesis, proves the reality of its dangers.

Blood poured into the pleural cavity, as a rule, coagulates rapidly, and will, at first at least, yield but few signs of its mixture with air; therefore Hippo-

cratic succussion is often wanting, or difficult to obtain, in the early stages of these cases; nor is the effort to obtain it either likely to be made, or justifiable, while the desire for absolute rest and freedom from respiratory effort, which such wounds demand, controls both patient and surgeon. The opposite conditions are often present—great oppression, dyspnoea, and orthopnoea—the results of the extreme effusion of blood alone, of air alone, or of both, into the pleura. Between cases of the first group and those of this gravest degree, are a large series in which it has been suggested to favor the accumulation, or rather retention, of blood or of air, to induce pressure in the pleural cavity, as a means of mechanically compressing the lung to arrest bleeding. In the last series, the efforts are made in the opposite direction. It is advisable to make efficient drainage, and even to withdraw the thoracic contents by aspiration to relieve urgent dyspnoea. Just as the lung has been observed to collapse, or again to remain uninfluenced by exposure of the pleural surface to atmospheric pressure, so each of these opposite plans of treatment has, in the first period of penetrating wounds, been found in particular instances to afford relief.

The advocates of “hermetical closure” record many cases of instant relief from the adoption of their method, and while there is abundant proof that the indiscriminate adoption of this practice has been most disastrous, one must be prepared in an emergency to adopt either plan.

TREATMENT OF PLEURAL EFFUSIONS.

It has been clearly shown¹ that blood shed into the pleural cavity coagulates rapidly, and separates into coagulum and serum; that if the amount is moderate, the serum becomes absorbed by the third or fourth day; and that on inflammatory reaction supervening, the change is limited to the circumference of the clot, presently leading to its inclosure in a cyst. But if the amount of blood be great, the serum of the clot is not absorbed when reaction occurs, and empyema results. Air, whether introduced by the wound in the chest-wall or by that in the lung, may equally be rapidly absorbed; if the opening in the lung be small, its sides rapidly adhere, and close by circumscribed effusion of lymph; in these cases, or in those that may be presumed to be such, the closure of the external wound is indicated, but where cases of the opposite kind are the subject of treatment, open wounds, suitably guarded from the introduction of septic material, are to be maintained. In the treatment of traumatic empyema, or of blood-effusion which must from its size and irritating condition terminate as such, the line of practice is not in any respect different from that appropriate to idiopathic empyema; only the cases differ in the fact that already there are external openings, and the proceedings are to be governed by the position and form of these, in arranging for a proper discharge of the retained fluid.

Admitting the foregoing statement, it is clear that the fluid which accumulates in the pleural cavity after penetrating wounds (if we except the rare occurrence of wounds of the œsophagus), may be either blood, serum effused from the pleural surface, or pus. The first and obvious element of diagnosis is the time of development of the signs and symptoms; if these supervene in the first few hours, no doubt can arise, for blood alone can be poured out in sufficient quantity under such circumstances; but delay in the development of symptoms and physical signs does not preclude the diagnosis of blood-effusion, for at any period of these wounds an intermediary or secondary

¹ Ch. Nélaton, Des épanchements de sang dans les pleures.

hemorrhage may occur, as it may in wounds of other parts of the body. I have quoted above a marked example of such delay in the development of blood-effusion.¹ An inflammatory effusion, but still serous in character, as has been observed by C. Nélaton, may occasion the signs of pressure and displacement of the thoracic viscera—this fluid originating during the process of the blood-coagula becoming encysted. Lastly, the signs of pressure from fluid effusion may be, and in these conditions are, most commonly due to purulent effusion. If the wound be a bullet-injury, if it be freely open either to the external air or to the bronchial surface, and if a time sufficient for the development of pus have elapsed between the receipt of injury and the development of signs of fluid-effusion, the doubts as to its nature can be but few. Assuming the position or form of the wound to be unfavorable for enlargement, or that the wound has been closed—under these conditions, which must necessarily be the most exceptional, the solution of the problem as to the qualities of the fluid should be determined by an exploratory puncture with the aspirator. The treatment to be adopted will be decided by the result of the exploration. If the fluid to whose accumulation are due the symptoms of intra-thoracic pressure, be blood-serum or serous pleural effusion, its withdrawal with the aspirator—proper attention to cleanliness of the instrument and to the avoidance of entry of air being assured—may suffice to terminate both the symptoms of distress and the formation of fluid. A single tapping may, as was noticed in the discussion of pleural effusion following contusion of the chest, accomplish this object. If the fluid prove to be purulent, further proceedings must be adopted, for with our present knowledge the reproduction of the purulent effusion is a certainty. Temporary relief may be obtained, and in some cases it may be the only object desirable to be obtained, by drawing off a certain amount of pus. A cure without a free discharge of the fluid, which cannot be obtained by the aspirator alone, is an impossibility.

Of the many devices proposed, there are but two which demand the attention of the practical surgeon: free incision of the pleural cavity, and the more guarded antiseptic evacuation of the empyema, combined with free drainage. Naturally, where wounds exist or are only recently closed, or, though existing, yet fail to provide a free escape for the fluid, a free incision enlarging the original opening will be preferred; but if the wounds are unfavorably placed, a counter-opening in a suitable, dependent position should be made. In making a counter-opening, care must be taken that the point selected is one from which it shall be possible to reach the cavity containing the fluid; to select, in obedience to formal rules, any particular site, must some time lead to disappointment, for an adhesion of the lung, or the presence of encysted coagula, may defeat the object of the operation; if it be possible, the point of incision should be determined, in making counter-openings, by the introduction through the wound of a probe or sound, which, projected against the wall of the cavity from within, may serve to guide the incision. In the case of a closed wound or wounds, so placed as to render this process impossible or unadvisable, a careful physical examination, and a preliminary exploration, should determine the spot for operation. A strange error has been current, that a point low down in the chest, either in front, or at the side or back, should be chosen for the incision, so as to provide for a dependent flow—an incision between the eighth and ninth, or ninth and tenth ribs; but such a position, apart from the risks to the diaphragm and abdominal viscera which it entails, will not be placed in the most dependent part of the pleural cavity, unless we assume that the patient is to spend the

¹ McDonnell's case, page 398, *supra*.

period of treatment standing or sitting up. As a man lies, the borders of the fourth, fifth, and sixth ribs, in the line of the posterior axillary fold, or in front of it, are the most dependent points. The opening, if a seat of election is at the command of the surgeon, should be placed, for either free or modified incision, so that, while dependent, it is still convenient to the patient and surgeon. To fulfil these conditions, a position midway between the lines of the anterior and posterior axillary folds seems most suitable, and has proved so in practice. In making the opening, it is necessary to define, if possible, the trunk and main branches of the long thoracic vein, which rather than the artery is apt to give trouble if wounded. This complication is, indeed, more likely to occur in chronic empyema, where the vessel itself and its branches are prone to be enlarged, rather than in the conditions of acute disease attending on a wounded thorax. The accident, too, would be trivial in its consequences, but it would embarrass the operation, and might, with a patient much enfeebled by disease, cause temporary anxiety.

Assuming that the position of the opening is to be fixed, either at the seat of election above indicated, or where the physical signs may dictate, and assuming further that the opening is to be made without reference to the site of the wound—under these conditions (I have already described the method of operation, viz., a counter-opening made by cutting down on a guide introduced by the wound) there is no difference between the operation as done for idiopathic or for traumatic empyema. The experience of the present day affords ample proof that the proper course to adopt, is to verify the site of effusion by a preliminary puncture, and at the same time to determine with the aspirator the quality of the fluid to be evacuated. The physical signs most to be relied on as indicating the presence of fluid, are the absolute dulness of the part on percussion, the absence of respiratory murmur and sounds, and the destruction of vocal fremitus; without this combination, the surgeon should hesitate to puncture even with an exploring needle; with it, if well defined, he should, before undertaking a more extended operation, add an exploratory puncture to verify the diagnosis, and to gain information as to the kind of fluid. Supposing the fluid to be found a clear serum, as was noted above in a case of contusion of the chest, the evacuation of the fluid, as far as the aspirator will effect it without distress to the patient, or signs of local trouble or obstruction to the tube, may and often does suffice to arrest the disease. In conducting this proceeding with the fine needle, even a valvular puncture effected by slipping the skin to one side while the needle enters, seems unnecessary, for the fine needle makes a wound too small to require the precaution; if its subsequent enlargement is demanded by the character of the fluid, even the slight variation of place caused by the valvular opening is a disadvantage. I assume that, with our present knowledge of the damage causable by the use of unclean instruments, even those least wedded to antiseptic surgery will admit that a scrupulous attention to the cleanliness of the exploring needle is essential, in view of the possibility of the chest-fluid being still only serum, or, if purulent, not as yet infected by decomposing material. To effect the removal of the fluid, should it be found to be serum, repeated applications of the exhausting syringe will be necessary, unless the instrument be one of large size; using the ordinary instrument, which is quite sufficient, it becomes necessary, in order to avoid the accident of entrance of air, that the fittings of Potain's canula, or some such device, shall be adopted, for in the shiftings necessary to empty the receiver, if the tube be not guarded by a proper stop-cock, air will enter, particularly if the patient cough.

Thus far we have considered the conditions which are presented by a case

in which a fair presumption may exist that the fluid is serous. In this case its removal is provided for by the adoption of means which are sufficient both for exploration and for the evacuation of a serous effusion. Let us suppose, however, the fluid to be found to be purulent; the exhausting syringe will remove this too, for it flows readily through the fine needle under pressure. Why should not the same means that serve in the case of serous effusion, be applied to it, and the entire purulent accumulation be removed? These means can never remove all the fluid, and while in the case of serum only, absorption will remove the remainder, in the case of purulent effusion the matter will be reproduced, absorption of pus being in practice a myth. To deal then with this emergency, the operator must be prepared with means more efficient than the aspirator. In revealing the quality of the fluid, this instrument does good service; it is an abuse of the instrument to set it to do work beyond its scope. The fluid having been proved to be purulent—a condition most likely, indeed almost a certainty, in penetrating wounds—how is the operator to proceed? Circumstances may be such that antiseptic treatment is impossible, although these must indeed be rare, even in the exigencies of a campaign. Suppose however that such treatment is impossible, or that from the condition of the fluid escaping, say by the orifices of the wound, it is for a time at least superfluous; under these conditions a free incision, made at the point already indicated, passing along the upper border of a rib, should be adopted, and so the freest possible escape for fluid provided. Subsequently, the injection, or introduction by irrigation, of antiseptic solutions may be practised, but at the first, and chiefly, reliance must be placed on a free and dependent incision. If it be admitted that injections to cleanse the cavity are desirable—and all, even the oldest, authors commend them—a suitable antiseptic treatment of the orifice and surroundings of the wound is clearly advisable. Under conditions favorable to antiseptic operation, it has been amply proved that the treatment of an empyema can be accomplished with great success, even in cases of long standing, in which the compression and adhesions of the lung may be presumed to be extensive and fully established. A protracted treatment, extending over many months, has been fully rewarded by the restoration of the lung, and by the permanent closure of the openings. If success of this kind can be obtained in idiopathic empyema, we may fairly expect even greater success in the traumatic form, where the lung's condition (the immediate dangers of the wound having been avoided, as they must have been before an empyema is formed) is more favorable to recovery if life be prolonged through the risks attendant on suppuration.

A strict Listerian treatment may of course be adopted, with a free incision practised as has been above directed, but experience has proved that a less severe and equally efficient method can be employed thus: The chest-wall, at and around the site of operation, being cleansed with a carbolic lotion of a strength of 1—40, and the instruments and operator's hands being likewise duly cleansed, a carbolic spray is made to play fully over the region; an incision, half an inch in length, is then made with a scalpel or lancet over the upper border of a rib, at the seat of election already determined by exploratory puncture, the line of the incision being in the direction of the rib border; a trocar and canula of the size of a No. 12 catheter (English gauge) is thrust through with a smart plunge, guarded by the index finger suitably placed on the canula, into the pleural cavity; the trocar having been withdrawn, as the stream of pus flows, the left forefinger checks the flow for a moment until a full-sized French drainage tube (No. 10, English catheter gauge), fully carbolicized, is taken up and held ready to be inserted in the canula; everything being ready, the finger is raised, and the tube passed against the pus-stream

into the chest. A full foot at least of tubing should be used to start with. The tube being passed in as far as it will go readily, the canula is withdrawn, while the tube is held in place. The fluid is let flow as long as it will, the spray playing steadily on the opening, but while the entrance of air into the chest is not solicited, no precaution is taken to avoid it; as the fluid drains away, the tube is transfixed with a needle carrying a stout silk thread, or better a link of good salmon-gut, and being held securely by the silk or gut, as the case may be, is cut off flush with the skin, the ends of the ligature being knotted in a safe knot which shall not be liable to slip, and fastened with a slip of isinglass plaster to the chest-wall, at some little distance above the opening. An antiseptic dressing is duly applied and secured, and the operation is completed. It is well not to complete the dressing until all matter which will flow without pressure or effort has ceased to run, for thus a longer interval will be obtained between the operation and the first subsequent dressing.

The advantage of the salmon-gut above either silken thread or silver wire, in retaining the tube in place, is that its stiffness is sufficient to prevent the tube slipping either in or out, while it is pliant enough to prevent irritation by its ends constantly pricking the skin. Nothing should prevent the careful securing of the tube, for it is prone to slip either inward or outward; if inward, it may be difficult to withdraw it, and a thread which is too weak may break in the attempt; or if the knot have been tied in a "granny" it may slip, and thus the tube, as we have seen, may be lost in the chest. If the tube slip out, trouble and inconvenience result too, but of less importance. The form of antiseptic dressing used may be either Lister's gauze, or Thiersch's salicylic jute and cotton, or a combination of both. In the early stages of the case, when the discharge is apt to be great and often variable in amount, the combination appears preferable, as the carbolic gauze, with its included layer of Mackintosh, protects the region of the wound from too direct a stream of air, while the salicylic jute, applied immediately over the wound, yields a constant supply of a non-volatile antiseptic to the fluids passing through its fibres; thus the fluid, should it flow out beyond the margins of the dressing, carries a sufficient amount of the acid with it to prevent its putrefaction—a security which carbolic acid will not give, for its volatility allows the fluids freely exposed to the air to putrefy rapidly. At a later period, when the discharge has become limited and constant, or steadily diminishing, in quantity, an external dressing of salicylic cotton, carefully fixed to the chest-wall, furnishes a perfect filter to the air, entering even directly through its fibres and those of a jute-pad placed beneath. At each dressing, a spray is directed over the region of the wound, and the details are carried out in all respects as in ordinary wounds, except only that the drainage tube is maintained of full size, and pervious, with a free flow of air in and out during the movements of breathing. Should the tube, as the discharge diminishes, become blocked, so that air cannot enter—an accident particularly likely to occur as the disease abates and the discharge is reduced to a few drachms—a change of dressing becomes necessary, for the patient grows uneasy and restless from the defective movements of the chest; as the cavity becomes closed, the tube may be gradually shortened, and at last, after careful examination of the physical signs, withdrawn, but this may only be done when respiratory sounds are audible in close relation to the opening. It is better to err on the side of overlong maintenance of drainage, than to risk a too early removal of the tube. All these processes may extend over a period of many months, but with either dressing, perfect antiseptic results, and finally recovery, may be obtained, with ordinary care and appreciation of the principles which govern such cases.

It has been recommended by high authority,¹ to maintain the drainage of the cavity of the pleura, with antiseptic treatment, by means of a canula of silver accurately fitting the wound, and closed by a silver lid. With this arrangement the fluid is to be washed out by a double tube (two Nélaton's catheters) twice in the twenty-four hours. I am convinced that this method is too complicated, and not in any way superior to the use of a simple drainage tube carried to its full length, shortened when necessary as the cavity fills up, and maintained constantly free for the ingress and egress of air duly filtered by a well-adjusted dressing. Only one trivial point is worth noticing: the ordinary French drainage-tube, perfect in other respects, contains overmuch sulphur; from this no harm accrues at first, except that an uneducated nose may fear that decomposition has taken place, when in reality only the tube has furnished an odor of sulphuretted hydrogen. At a later stage, when the discharge, in a case passing on to a favorable issue, has become serous in character, it will be found that a fresh piece of tubing, used for fear of the old one being decayed or damaged, will provoke a fresh discharge of pus for a few days, by its irritating chemical composition. It is well then to start with two tubes, to have one ready for change at each dressing, and, if it be possible, to avoid new tubes subsequently; better still is the use of pure-rubber tubing, free from an excess of sulphur. As many accidents have happened in the use of pleural injections—notably, in some cases, poisoning by carbolic acid, and sudden and unexplained death in others—it is far better to abstain from their employment; they may be necessary in some cases, but in most they may be entirely dispensed with. The methods of puncture through a rib, which have been of late, and long ago, proposed as substitutes for the opening in an intercostal space, do not appear to offer any substantial advantage. A drainage-tube is always sufficient to maintain the ordinary opening, and it would appear to be only courting a further source of irritation, to establish unnecessarily caries or necrosis of a rib, such as must result from this proceeding.²

Doubt has of late years been expressed as to the possibility of *pneumonia* occurring as a result of wounds of the lung, or even contusions of its structure; on the other hand, the statement is made that pneumonia is an invariable sequence of wound of the lung, and constitutes one of the great secondary dangers of this injury. (Erichsen.) In the American war returns, we find that traumatic pneumonia "is noted as a grave complication in two hundred and eighty-five of the penetrating, and seven of the non-penetrating wounds of the chest, and resulted fatally in two hundred and twenty-two of the former and six of the latter group." From these facts it is clear that in the statement of Mr. Erichsen there is an error of excess, for the total number of cases is comparatively small, when we consider the number of chest wounds recorded (20,607). This difference of opinion is, to some extent, due to the various senses in which the term pneumonia is interpreted; it cannot be doubted that neither catarrhal nor croupous pneumonia arises from a wound, but it is clear that an inflammation, tending to suppurative action and to gangrene in the tissues in immediate relation to the wound, occurs, and may implicate a greater or less area of the lung; in this the lung does not behave differently from other tissues. That such is the case, appears very clearly in the following passage:—

This (gangrene) occurs in case of lesions caused by stabs or gunshot wounds, when under unfavorable circumstances the opening does not heal, but by means of intense

¹ Fraentzel, Ziemssen's Cyclopædia, vol. iv.

² Resection of the ribs for empyema has been already referred to in the article on Excisions, Vol. III., page 577.

reactive inflammation, with considerable infiltration, the surrounding parts are thrown into suppuration, with the formation of abscess and gangrene. It may also be found to occur from severe contusions of the thorax, for instance, injuries of the shoulder. The elasticity of the chest-wall allows the contusion to act on the lung, and thus to produce effusion of blood followed by gangrenous sloughs.¹

I have already quoted a remarkable case of this kind in connection with contusions of the chest.

PARACENTESIS OF THE PERICARDIUM.

In searching the annals of surgery to discover the relationship of this operation to the subject of injuries of the thorax, the student is forced back to the case of Larrey,² for he will fail to find instances in which the operation has been resorted to for the effects of injury since his time; before that period the records of the operation are still fewer—certainly they are silent in relation to wounds. Trousseau,³ who of all ancient or modern writers is the exponent of the operation, singularly denies a place to the record of Larrey, declaring that both his case and that of Desault⁴ are “cases of alleged paracentesis of the pericardium, both originating in errors of diagnosis.” While I freely admit that Desault’s case was a failure in both diagnosis and result, although it indicates the mode of operation most clearly, I deny that Larrey’s case is to be so classed. To him it appears that we must attribute the first operation of paracentesis pericardii—certainly the first, it may be the only one, for effusion the result of wound. It is strange that Trousseau should tell us that Larrey recommended an opening between the edge of the ensiform cartilage and the cartilage of the eighth rib on the left side, a statement approved by Le Fort, and current to-day in the *Cyclopædia* of Ziemssen, while we find Larrey himself telling us:⁵—

“J’incisai d’abord la peau et le tissu cellulaire de l’espace intercostal de la cinquième à la sixième côte au-dessous du mamelon et sur le bord inférieur du pectoral; je coupai par couches, et parallèlement à la direction des côtes, les muscles intercostaux. Parvenu à la plèvre costale, je modérai l’action du bistouri, pour ne pas dépasser cette dernière cloison, si le cœur en avait été très près.”⁶

Such are the words of Larrey, and yet we find Trousseau asserting that “Larrey believed that it was easier and more convenient to make the puncture between the edge of the ensiform cartilage and the cartilage of the eighth rib on the left side.” In his operation, Trousseau adopts the plan formulated by Desault and Larrey, varying the intercostal space only, but making no mention of either of these writers whose method he adopts. Next he considers the operation of Aran, performed with a capillary trocar; this method, though successful in the particular case which he quotes, he condemns as entailing too great risks. As far as the operation and its details are concerned, we have not advanced in these days; certainly in relation to traumatic pericarditis, the question remains as Larrey left it. The American war

¹ Hertz, Ziemssen’s *Cyclopædia*, vol. v. page 412.

² *Mémoires de Chirurgie Militaire*, t. iii. p. 458.

³ *Lectures on Clinical Medicine*, New Sydenham Society’s Translation, vol. iii. page 364.

⁴ *Œuvres Chirurgicales*, t. i. p. 304.

⁵ *Op. cit.*, tome iii. p. 466.

⁶ [I divided first the skin and cellular tissue of the intercostal space from the fifth to the sixth rib, below the nipple and along the lower border of the pectoralis; I cut the intercostal muscles layer by layer, and in a direction parallel to the ribs. Having reached the costal pleura, I checked the action of the bistoury, so as not to get beyond that last partition, if the heart had been very near it.]

gives no instance of a wound which gave rise to effusion, relieved, or which should have been relieved, by puncture of the pericardium. Indeed, silence in this matter is perhaps best, for but few have had opportunities for treatment of pericardial effusion by puncture. All are ready to diagnose with precision, in idiopathic cases, the existence of effusion, but none have advanced much further in exactness than Larrey, even though he was ignorant of the use of the stethoscope. I have known the errors of Desault in diagnosis repeated—not indeed to the extent of opening the chest for pericardial effusion—but little short of this; the diagnosis made by the physician, and the case remitted to the surgeon for operation, where no fluid whatever existed in the pericardium. Caution, then, in this matter must lead me to advise, if an operation is to be undertaken, that the surgeon should follow the mode of Desault or Larrey, rather than adopt the puncture with a capillary trocar, as practised by Aran. I freely admit that the modern successes of Allbutt and others in puncturing with the trocar are against this view; but in the uncertainty that must attend the diagnosis of a traumatic pericarditis as compared with the idiopathic form, which is usually the subject of this mode of treatment, I incline to the more cautious practice. [The operation by *incision* is said to have been first practised by Romero, in 1801. It has recently been revived by Rosenstein, Kummell, Partzevsky, and S. West. The literature of pericardial paracentesis, which may be conveniently performed with the aspirator in either the fourth or the fifth intercostal space, has been particularly studied by Dr. J. B. Roberts, of Philadelphia, who has collected 41 cases of which 22 were fatal, but in most instances from causes independent of the operation.]

The oldest method proposed for the puncture of the pericardium—the perforation of the sternum by the trephine, proposed by Riolan—leads us to the complication of chest-wounds for which this operation has been practised successfully, namely the development of abscess in the anterior division of the mediastinum, as the result of fracture or gunshot contusion of the sternum.

MEDIASTINAL ABSCESS.

Probably the opportunities for the study of this affection as the result of gunshot injury of the sternum are past, for the conical rifle-bullet of the present day will be rarely found to strike and fracture the bone, and fall out of the wound, as in the early cases of mediastinal abscess recorded by Petit. The symptoms which such an abscess give rise to are the development of fever in the early stage of the wound—about the fifth day—or at some more remote period, with rigors; a sense of weight and oppression in the front of the chest, with pain in coughing, drinking, etc.; after the occurrence of cough, breathlessness “as if one had been running;” and more or less œdema over the sternum. With these indications, Petit applied the trephine at the site of the wound with success, giving issue to pus pent up behind the bone. There is no doubt that this treatment was correct, but we may doubt the statement of Petit,¹ that, had it not been adopted, the result would have been fatal; for the area of the sternum is so limited that, in all probability, matter, forming behind it as the result of injury to its tissue, would speedily make its way to the surface at one or other of its borders. Arising in circumstances other than those of injury—as the result of caries, either scrofulous or syphilitic—the matter which forms behind the sternum escapes either laterally or

¹ Il n'y a pas lieu de douter que le malade fût mort si on ne lui avoit pas fait cette opération. Petit, *Traité des Maladies Chirurgicales*, tome i. p. 143.

into the neck, or through perforations of the bone either produced by the disease or congenitally present. It is therefore probable that traumatic abscess would take some similar route to the surface. The trephine may be necessary in the later stages of an abscess which has already opened externally, for matter may be retained in the mediastinum, and, the opening being above, as in Lamartinière's case quoted by Chassaignac,¹ a dependent flow sufficient to drain the cavity may perhaps only in this way be obtainable.

In the details of examples of shot-fracture of the sternum recorded in the History of the American War, but little prominence is given to the phenomena of mediastinal abscess; indeed, in many there appears to have been but little proclivity to suppuration in the tissues of this region, even though exposed to such an extent as to render "the arch of the aorta distinctly visible." Nor are these injuries in any way foremost in the bill of mortality.

WOUNDS OF THE ŒSOPHAGUS.

In rare instances of penetrating wounds of the chest, the œsophagus has been wounded without lesion of any of its important surroundings. Both in gunshot injuries and in stabs, this accident has happened, the lung and pleura only being wounded in addition. The cases are so few that we are obliged to fall back on the only recorded example, unequivocal in its character, in which recovery has resulted. Boyer,² who publishes the case, introduces the subject thus: "Wounds of the œsophagus are very grave, but they are not always mortal. When the wound is limited, and is not accompanied by a deep lesion of the lung, the patient may recover."

The case he records was that of an exciseman, aged 24, in robust health, who was stabbed with a bayonet in the upper and anterior part of the right side of the chest, in the discharge of his duty. He ran for his life, followed by the offender whom he had discovered; he ran more than half a league without feeling pain in the wound, but shortly after coughed up some blood. An hour after the accident, when M. Payen saw him, his condition was one of inexpressible agony. He lay on his right side, breathing with difficulty, and with pain in the whole right side of the chest, reaching to the hip. His pulse was rapid, and the least movement was difficult and painful. An angular wound of four lines in extent existed one inch from the sternum on the right side, between the third and fourth ribs. The wound was not bleeding, but at each expiration, and especially during a fit of coughing, the air escaped from it with a force sufficient to blow out a candle seven or eight inches off. The wound was dressed with a compress, and the patient was twice bled at the arm, with relief. Next day the pulse was strong, the pain still acute, the cough less frequent, but the breathing constantly labored. He was bled a third time as freely as before; he had ceased to spit blood. On the third day, when the compress, which had stuck to the wound, was detached, a great quantity of very red fluid, thinner than blood, escaped; after this the breathing became easier. In the evening a similar discharge, equal to the first in quantity, occurred, and of the same character. This diminished the anxiety which had existed. From this time the fluid flowed constantly, escaping by jets when the wound was open and the patient coughed. It continued to flow during many days in such abundance that a great number of towels were soaked in the twenty-four hours. From day to day the color of the fluid was less deep in tint. On the tenth day it was almost colorless. Although the patient drank much, his urine was scanty and very high colored, and loaded with deposit. "I suspected then," writes M. Payen to Boyer, "that the prodigious quantity of fluid which the wound furnished was derived from the drinks, which, instead of passing into the stomach, escaped into the right side of the chest through a wound in the central part of the thoracic course of the œsophagus.

¹ *Traité de la Suppuration*, tome ii. p. 330.

² *Maladies Chirurgicales*, 5e éd. tome v. p. 670.

To test this theory I administered to the patient oily draughts, mucilaginous drinks variously stained, egg-flip, and the like. All these stained the compresses unaltered. Having examined carefully the form and dimensions of the bayonet which had inflicted the injury, I concluded that the wound of the œsophagus must be of very small size, as the weapon must have been stopped by the spine in transfixing it. Two means suggested themselves for treatment—either to use the tube of the stomach-pump to feed the patient, or to stop altogether, or as far as possible, swallowing of food or drink. I adopted the latter, as the simplest and least inconvenient. It was the more easily adopted as the thirst had become less urgent in consequence of the diminution of fever. The patient submitted readily. I permitted him only to clear the mouth, from time to time, with a little flake of orange, and gave him nutrient enemata. Enfeebled by the bleedings and antiphlogistic treatment, the patient experienced at the end of four days cravings that could not be satisfied by the new diet. I yielded to his entreaties, and let him swallow a few spoonfuls of drink. The fluid which the wound yielded was not made more abundant, and presently this discharge was pus only, which I attributed to the entire absorption of the liquid previously extravasated. At last, confirmed by success, I administered nutritive drinks, and finally solid food. . . . The patient's strength returned slowly, and not before many months was he able to return to duty.

A case illustrating the more probable result in this injury is quoted in the "*Leçons Orales*" of Dupuytren:—

A woman was brought to the Hotel Dieu for a deep wound inflicted by a knife above the clavicle of the left side. She died on the seventh or eighth day after her admission. At the autopsy, astonishment was expressed at finding the left side of the chest filled with the drink, and even with some of the solid food, which the patient had taken. The whole was mixed with pus. A large wound existed in the thoracic portion of the œsophagus; the food and drink had not escaped externally, and no sign during life suggested any lesion of this part.

But a single example is noted in the report of the War of the American Rebellion,¹ an instance of laceration without complete penetration of the œsophagus by bullet injury, discovered only by post-mortem examination.

In these examples of this rare lesion, we find no mention of the symptoms of wound of the œsophagus relied on by some—thirst and hiccup (*Modière*).² The positive sign relied on by Boyer remains: "*Mais le signe non équivoque est la sortie des boissons et des alimens par la plaie.*"³ The objection to the conclusiveness of this sign which has been raised (*Knott*),⁴ that wound of the larynx may be mistaken for that of the œsophagus, in consequence of the escape of liquids which have entered the wounded larynx in individuals suffering from grave depression, applies only to wounds of the neck, not to penetrating wounds of the chest. Wounds of the thoracic portion of the œsophagus by hard and pointed ingesta, its ruptures during vomiting, and the occurrence of ulceration, abscess, or diffuse inflammation of the mediastinum, induced by impaction of angular fragments of bone in the tube, lie outside the range of an article on injuries of the chest, in the ordinary acceptance of the term.

Our knowledge of the phenomena attending the lesions of the intra-thoracic portions of either the *par vagum*, the *phrenic*, or the *sympathetic nerves*, is as yet, as far as regards their relations to the symptoms of penetrating wounds of the chest, too imperfect to justify any conclusions of practical importance. In a similar state is the information at our command regarding wounds of the *thoracic duct*.

¹ Medical and Surgical History, etc., Part First, Surgical volume, p. 506.

² Archives Générales de Médecine, 2e série, t. ii. p. 520.

³ [But the unequivocal symptom is the escape of drinks and food by the wound.]

⁴ Pathology of the Œsophagus.

DISEASES OF THE BREAST.

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It is proposed to consider the Affections of the Breast under the following heads:—

(1) Anatomy of the Breast; (2) Congenital Peculiarities of the Breast; (3) Functional and Sympathetic Conditions of the Breast; (4) Atrophy and Hypertrophy of the Breast; (5) Inflammatory Affections of the Breast; (6) Irritable Breast; (7) Tubercular and Syphilitic Affections of the Breast; (8) Parasitic Affections of the Breast; (9) Affections of the Nipples; (10) Tumors of the Breast; (11) Affections of the Male Breast.

ANATOMY OF THE MAMMÆ.

The chief points of interest to the practical surgeon under this head are the following:—

CONNECTIONS AND BOUNDARIES.—These organs, as is well known, vary much in size and in feel in different women, and at different periods of life, and such variety is the result, in some instances, of functional changes; in others, it is due to the condition and amount of the fatty and other textures covering and surrounding the breasts, and in others again both these circumstances may affect their normal condition. Although these changes in size and feel occur, it may be considered, for all practical purposes, that except in the case of very pendulous breasts, the true glandular substance of the organ retains the same connections under all the alterations referred to.

The exact boundaries of the gland-substance are not always distinctly defined, and it is not uncommon to find processes of the glandular structure passing into the surrounding fatty tissue, and so encircled by it as to appear to be isolated from the breast itself. This fact is of importance in connection with the question of thorough operation in cancer of the gland. The base of each gland, almost circular in shape, rests upon the fascia covering the anterior aspect of the pectoralis major, serratus magnus, and internal oblique muscles, and is connected to it by a layer of areolar tissue. It extends from the third to the sixth or seventh rib, and its greatest diameter is transversely upwards and outwards towards the axilla. It is also important to note that the axillary and central portions are thicker than the other portions, and that one breast—usually the left—is, as a rule, larger than the other. Superficially, the ordinary integument, and more or less fatty tissue, cover the glands, and passing from the former to the latter are numerous processes or laminæ of fibrous tissue, which surround and strengthen the

gland-structure. These laminae, together with the areolar connections of the gland at its base, act in supporting or slinging the breasts, and keeping them in position. M. Giraldès¹ describes the circumference of the fibrous capsule of the breast as being continuous with the superficial fascia, and through it having an attachment to the clavicle, so as to constitute an additional means of supporting these organs. The areola, or skin immediately surrounding the nipple, is thinner than, and differs in color from, that covering other portions of the breast, and after puberty becomes dotted with small tubercles, which have a communication with sebaceous glands, and open externally. Its color is pink in the infant and red in the young adult, but it becomes dark-colored during and after pregnancy, in old age, and sometimes under other conditions. The nipple differs much in development in different persons. In some, it forms a well-marked projection, varying in color from a light red to a dark brown, according to the age and condition of the woman; in others, the organ is small or depressed, or may be absent. The skin covering the nipple is arranged in wrinkles, and is covered by papillae. Surrounding its base are tubercles, communicating, like those on the areola, with small glands, and at its top are several openings, the orifices of the milk-ducts. In addition to the skin and milk-ducts, the nipple is composed of muscular tissue and numerous bloodvessels, with delicate areolar tissue, and possesses the power of erection, to a greater or less degree in different women.

MINUTE STRUCTURE AND DEVELOPMENT.—The minute structure of these glands may be described as consisting of numerous lobes, subdivided into smaller lobes, and again into lobules, surrounded, connected, and supported by firm areolar tissue and more or less fat, in which the bloodvessels, nerves, and ducts are distributed. The lobules are vesicles of rounded shape, and from them small ducts arise, which join larger ducts, and these again unite with others so as to form from fifteen to twenty, which pass to the nipple and constitute the milk-ducts. These milk-ducts, when they reach the under surface of the areola, dilate and form small sacs, but at the base of the nipple they again contract and pass to its summit, where they open on to the surface by separate orifices. The vesicles and ducts are lined by epithelium, which is continuous through the milk-ducts with that of the skin covering the nipple.

According to the latest observations, the development of the breasts does not depend, as has usually been supposed, upon an involution of the cells of the cuticular epiblast, but takes place more in accordance with the views of the late Professor Goodsir.² Dr. Creighton, as a result of his important investigations in connection with the breast,³ considers that “the secreting structure is formed in a layer (of mesoblast) beneath the outer skin,” and that “the ducts, or communications with the skin, are essentially secondary formations, owing their existence to a force from within.” To quote further from Dr. Creighton, his conclusions are:—

- (1) That the mammary acini of the guinea-pig develop at many separate points in a matrix-tissue; that the embryonic cells from which they develop are of the same kind that give origin to the surrounding fat-tissue; and that the process of development of the mammary acini is step for step the same as that of the fat-lobules.
- (2) That the ducts of the mamma develop from the same matrix-tissue by direct aggregation of the embryonic cells along predetermined lines; that the ducts develop in the individual guinea-pig before the acini, whereas in the phylogenetic succession the ducts

¹ Mémoires de la Société de Chirurgie de Paris. 1851.

² Anat. and Path. Observations. 1845.

³ Physiology and Pathology of the Breast.

are a later acquisition; and that this reversal of the order of acquisition of parts is in accordance with the principle stated by Mr. Herbert Spencer, that under certain circumstances the *direct* mode of development tends to be substituted for the *indirect*.

ARTERIAL, VENOUS, NERVOUS, AND LYMPHATIC SUPPLY.—The principal *arteries* which supply the mamma are branches of the long thoracic, internal mammary, and intercostal vessels. They vary much in size, according to the functional condition of the organ, and they, as well as the veins, are usually much enlarged when a large or vascular tumor is present. In operating upon the breast it will be found that the chief arteries enter it at the axillary, upper, and sternal margins, and at its under surface.

The *veins* correspond in great measure to the arteries, and pass principally into the axillary and internal mammary trunks. Around the base of the nipple the veins form a special anastomosis, which is termed the *circulus venosus*.

The *nerves* which are distributed to the breasts are cutaneous branches of the anterior and middle intercostal nerves, and these by their union with filaments of the lower cervical nerves constitute a nervous connection with the skin over the breast, in the axilla and inner aspect of the arm, and over the shoulder.

The *lymphatics* of the breast are superficial and deep, and pass, some into the glands of the axilla, some into those in the lower cervical region, and others into those of the mediastinum. It is important to note that the cervical glands may become affected in diseases of the breast without involving the axillary glands, as lymphatics pass directly to the neck, superficial to and beneath the clavicle, and also that the mediastinum and pleura may in the same manner become directly involved in disease passing along the lymphatics.

CONGENITAL PECULIARITIES.

SUPERNUMERARY NIPPLES AND MAMMÆ.—These occur most frequently in the region of the mammæ, but they are sometimes met with in the axilla, and there are on record four apparently authentic cases, in two of which the supernumerary organ was on the back, in one over the acromion process, and in one on the outer side of the thigh. There are also at least two cases recorded in which supernumerary nipples have been situated in the abdominal wall. Numerous individual cases of this malformation have from time to time been reported, but I would especially direct attention to a most full and valuable paper on the subject by Professor Leichtenstern.¹ Dr. J. Mitchell Bruce has also written a most interesting paper on this condition.² In the same journal Mr. Cameron describes three cases of this deformity, and refers to many others. During a period of two years and nine months, Dr. Bruce himself observed, in the out-patient department of the Hospital for Consumption, Brompton, sixty-one cases of supernumerary nipples or mammæ, and he expresses the opinion that this malformation is much more common than is usually supposed. The following is Dr. Bruce's general summary of the results of his careful investigations:—

(1) That sixty-five cases of supernumerary nipple were observed within a period of three years. (2) That of 315 individuals taken indiscriminately and in succession, 7.619 per cent. presented supernumerary nipples. (3) That 9.11 per cent. of 207 men examined in succession presented supernumerary nipples, and 4.807 per cent. of 104 women. (4) That in the great majority of instances the supernumerary nipple was

¹ Virchow's Archiv, Bd. lxxiii. H. 2.

² Journal of Anatomy and Physiology, vol. xiii.

single; that it was without exception situated on the front of the trunk, below and within the ordinary nipple, and more frequently on the left side than on the right. (5) That the distances of the supernumerary nipples from the ordinary nipples are very various, and from the measurement of these distances a series of numbers may be attained which may possibly suggest the unit of distance between the successive pairs of nipples in the original type. (6) That a supernumerary nipple, though frequently well marked, is more frequently small or deficient in one or more of its elements—papilla, areola, follicles, or hairs. (7) That in no case was the supernumerary organ physiologically active, but that in a few cases supernumerary glands appeared to be present (in single women). (8) That inheritance was not traced in any instance. (9) That in more than one instance the anterior abdominal wall was the seat of the abnormality.

It would appear, then, that these supernumerary organs are rarely functionally useful or active, but exist as simple rudimentary appendages. Should a supernumerary mamma or nipple be causing deformity or inconvenience, its excision would be justifiable, but otherwise interference in such cases can rarely be necessary.

CONGENITAL ABSENCE OF MAMMÆ.—A few cases are on record in which one breast, usually the right one, has been entirely absent. In these cases there has been, in addition to the absence of the breast, more or less deficiency of the chest-wall on the corresponding side. In one case described by Froriep, the greater part of the pectoralis major muscle was absent, and the third and fourth ribs were deficient at their sternal ends.¹

FUNCTIONAL AND SYMPATHETIC CONDITIONS OF THE MAMMÆ.

Physiologically, it may be said that the function of these organs is to secrete milk in order to furnish nourishment for the infant, but as the secretion of milk occasionally takes place under other circumstances, it may be well to remember the observations of Goodsir,² who has pointed out that the functional activity of a gland is identical with the original development of the gland in the embryo. Creighton³ also remarks "that the continuous and useful production of milk, which alone constitutes the function from the physiologist's point of view, is not the essential or primary activity of the organ, but a mere prolongation of its evolutionary force at its highest point." Dr. Montgomery, in his work on the Signs and Symptoms of Pregnancy, refers to cases in which milk has been secreted in the mammæ of young girls, and there are a few rare cases on record in which old women and even men have had a secretion of milk from their breasts.⁴ To the surgeon, lactation is principally of interest in connection with the fact that during its progress excessive action may lead to inflammation of the gland or tissues round it, and also with the fact that any obstruction to the passage of the milk along the ducts may lead to tension and inflammation, or to the formation of lacteal or other cysts. The influence that lactation or its consequences has upon the pathology of the morbid growths affecting the breasts, is likewise well worthy of careful study and consideration. It may be well here to note the fact that experience has shown that operations of any magnitude are best avoided, unless there be special urgency, when the breasts are in an excited condition, as during lactation, pregnancy, or menstruation.⁵ In the infant the mammæ are surgically

¹ For a detailed and interesting account of this case, see Froriep's *Neue Notizen*, Bd. x. April, 1839. In vol. xxiii. of the same work, another interesting case is described by Dr. F. Reid.

² *Op. cit.*

³ *Op. cit.*

⁴ *Med. Times and Gazette*, 1856; *Lancet*, 1857; *Brit. and For. Med.-Chir. Review*, vol. ii. 1852.

⁵ Paget, *Clinical Lectures and Essays*; Smith, *Braithwaite's Retrospect*, 1876.

unimportant organs, except that after birth they may become a little swollen and tender, and may secrete a small quantity of milky fluid. According to Peddie,¹ the milk is most abundant about the fifth day after birth, and is usually gone by the tenth day. It has the character of the mother's milk at the same period, with colostric bodies as well as milk-globules, but the latter are in sparing number and generally of larger size. It is present in male infants as often as in female ones. The proper treatment of this condition is to soothe the tender part by sponging it with warm water, and to apply over it a little cotton-wadding so as to protect it from any injurious pressure. [The habit which some nurses have of squeezing the infant's breast is to be severely reprobated.] In the girl, the mammæ usually remain in a quiescent state until puberty is established. The time at which this takes place varies under the different circumstances of climate, constitution, education, and social habits. The average age at which menstruation commences is between 14 and 16 years; it may be delayed until 18, and in rare cases until 23 or 24, and it may begin at 11 or 12. There are also rare cases reported in which menstruation has been observed in the infant or young child, with corresponding changes in the mammæ.²

After puberty has been established, the mammæ usually undergo some change at the menstrual period, and this varies in degree in different women. The amount of this change depends partly on the development of the organs, partly upon the constitution of the patient, and partly also upon the special condition of her life and surroundings. Ovarian or uterine irritation, or retention of menses, may lead to sympathetic enlargement or irritability of the breasts, in both young and old, and in married and unmarried. The changes to be noted under these conditions consist of some enlargement and tenderness, with occasional discharge of fluid from the nipple. The rare condition of vicarious menstruation may give rise to similar symptoms. The treatment of these affections consists in an endeavor to remove any cause of irritation, uterine, ovarian, social, or mental, the employment locally of soothing applications, the removal of any pressure of the dress likely to increase the irritation, and careful attention to the bowels and general health. In the woman who marries or otherwise parts with her virginity, the mammæ undergo changes; if pregnancy does not take place, the changes, which consist of swelling, tenderness, and knotting of the gland, are usually slight and soon pass off, but when pregnancy occurs, a marked alteration shows itself. The whole gland becomes firm and enlarged, and in some cases there is a feeling of tension and pain, either acute or pricking in character; the areola becomes darker in color and increases in size, and its tubercles are more marked. The nipple also becomes somewhat darker in color and more prominent. It may be well here to note that the changes just described vary in degree in different mammæ when pregnancy takes place. Occasionally little or no change is observed, and therefore the other signs of pregnancy should be studied in determining doubtful cases. The tension of the breast in pregnancy sometimes results in inflammation and suppuration, but this is not common. The condition of the mammæ which results from pregnancy does not often require treatment, but when the symptoms are severe, soothing applications to the breast, protection from local pressure and irritation, and attention to the general health, will be all that is required; if there is any secretion from the nipple, this organ should be carefully washed so as to prevent any scab forming which might obstruct the milk-ducts.

During lactation, cysts or cavities containing milk are occasionally met with in the breast, and these have been termed *Galactoceles*. Gross states

¹ Monthly Journal of Medical Science, 1848.

² London Med. Journal, 1849.

that of fifteen such cases, twelve occurred from ten days to seven months after parturition, one sixteen months before childbirth, one during pregnancy, and one twenty-four years after the last pregnancy.¹ They appear to be produced by the dilatation of ducts or sinuses which have been obstructed, or they may be the result of rupture of the canals. Such cysts form tumors, fluctuating or not according to the condition of their contents, which may be fluid or more or less solid. Gross mentions that out of seventeen cases, the contents in seven were pure milk, in two of the nature of cream, in one oil, in one a substance partly curdy and partly fluid, in five a semi-solid caseous matter composed of broken-down epithelium, globules of oil, and acicular crystals of palmitine and stearine, and in one a substance of the nature of butter. They are not usually attended with pain, but occasionally become inflamed. These cysts usually diminish in size when lactation has for the time ceased, but slowly increase during future pregnancies, until removed by operation. The treatment of these cases will depend upon the condition and contents of the cysts. If not causing inconvenience, they may be let alone until lactation is over; if they do not then disappear, and if the contents are fluid, tapping the cyst should first be tried, and if this does not cure, an incision should be made and a drainage tube inserted; when the contents are semi-solid, the cysts should be incised and a drainage tube introduced; when inflamed, they are best treated by free incision.

When menstruation has ceased—and the time for this varies between the ages of 40 and 51, exceptional cases having, however, been recorded, in which it has ended at the age of 30, or not until 55, or even older—the glandular structure of the breasts shrinks or becomes infiltrated with fat, and although the ducts may remain pervious, many of them are mere tubes, having no connection with cavities or acini, which have become obliterated. The pervious ducts are often distended with fluid or semi-solid contents, which, in some instances, can be pressed out through the nipple.

ATROPHY AND HYPERTROPHY OF THE BREASTS.

ATROPHY OF THE BREASTS occasionally occurs in both married and unmarried women, and in such cases the glandular structure is either from the first feebly developed, or becomes atrophied, as in the case of old persons, or persons suffering from ovarian or uterine disease. Such a condition does not admit of treatment.

HYPERTROPHY OF THE BREASTS depends upon an abnormal growth of the glandular structures, and usually commences soon after puberty. It has been met with in single and married women, and generally occurs in both breasts, although one alone has been known to be affected. Breasts attacked by this affection may attain a large size, and so cause both inconvenience and deformity. In some of these cases the breast is pendulous. The elder Gross met with a case in which the breast weighed 15 pounds, and he refers to another case in which the breast weighed 64 pounds.² This enlargement of the breast may be simulated by the growth of tumors having some resemblance to the ordinary glandular structure of the part; but in these cases the condition is not one of true hypertrophy. The diagnosis of this disease is determined by the uniform and permanent increase of the glands, occurring in a young adult, and progressing until the size of the organs is beyond that met with during any of their active functional conditions. Birkett³ describes

¹ S. W. Gross, Tumors of the Mammary Gland.

² Holmes's System of Surgery.

³ System of Surgery, vol. ii.

two forms of the affection; in one, the breast is large and firm, and the skin over it tense and smooth; in the other, the breast is pendulous, and is flat and flaccid. Dr. Guido Banti¹ has written a most instructive paper on this subject. After referring to the observations of Birkett, Velpeau, Virchow, Klebs, Birch, and others, he relates several cases, and specially describes and figures a remarkable instance of hypertrophy of both mammae in a girl. Both breasts were removed by Dr. Colzi, and the patient recovered. A careful account of the examination of the glands after their removal is also given.

As a result of his investigations, Dr. Banti gives the following conclusions:—

(1) The diseased state, called hypertrophy of the mammae, exists in two distinct forms. (2) One form constitutes false hypertrophy, which is divisible into three varieties. (3) The other form is a hyperplasia of all the structures of the breast, of the glandular as well as of the connective tissue. For this reason it ought to be termed true hypertrophy. (4) The true hypertrophy and the false are not stages of the same malady, but are entirely different diseases.

Hypertrophy of the breast does not readily yield to treatment, and should attention to the uterine functions and the general health, together with support and careful compression of the organs, fail in giving relief, the removal of one or both of them may be resorted to, but only if the condition is causing serious distress. When both breasts have been affected, the removal of one of them has, in one or two instances, been followed by a diminution in the size of the other.

INFLAMMATORY AFFECTIONS OF THE BREAST.

Inflammation may originate, as a result of injury or other causes, in the tissues over or near the breasts, without involving them, and this inflammation may or may not be followed by suppuration. In such cases, there is an absence of the characteristic induration of the gland structure, and the inflammation requires the ordinary treatment proper to its origin and nature.

MAMMITIS AND MAMMARY ABSCESS.—Inflammation of the mammae themselves occurs at all periods of life, and may be the result of injuries, such as bruises, wounds, or lodgment of foreign bodies; of sympathetic irritation; of local irritation in connection with the nipple, soft parts over or near the breast, or axillary glands; or of a strumous or weak constitution; but much the most frequent origin is in connection with lactation. In infants, this inflammation is met with soon after birth, and occasionally suppuration takes place, but this is exceptional; it occasionally occurs in young girls; sometimes during pregnancy; but in the large majority of cases in women who have borne a child, and most frequently in those who have been confined with their first or second child. Birkett² states that out of 118 cases of either inflammation or abscess, more than one-half had given birth to a first or second child, and nearly one-third were primipare; he also observed that out of 116 cases the inflammation commenced during the first month after parturition in half of them, and in a large proportion of these during the first week. Bryant³ relates that out of 102 cases, 79 occurred during lactation, two during pregnancy, and 21 in patients who were neither suckling nor pregnant; he also mentions that the right breast is more frequently affected than the left, in the proportion of five to three. Defects or affections of the nipple, obstruction of one or more of the ducts, sudden stoppage of

¹ Archivio della Scuola d'Anatomia Patologica di Firenze, tomo ii.

² Op. cit.

³ Manual for the Practice of Surgery.

suckling, mental excitement, exposure to cold, and feeble health, are the causes which give rise to inflammation during lactation. The usual symptoms of acute inflammation of the breast are, enlargement, hardness, and tenderness of one or more portions or lobes of the gland, and sooner or later redness of the skin over the affected part; there is also constitutional irritation, and there are frequently rigors. The inflammation may confine itself to one or more lobes, or it may involve the greater part of the gland; in cases the result of lactation, the whole gland, or a portion of it, may, in the first instance, be simply swollen and hard, without any marked signs of inflammation. Mammary inflammation may end in resolution, the gland recovering without change; it may result in some thickening of the breast structures; or it may end in suppuration. The progress of the inflammation varies in different cases; sometimes it is very rapid, and it is then usually quickly followed by suppuration, and accompanied by rigors and high fever.

When suppuration takes place, as the result of mammary inflammation, it may be circumscribed or diffuse, and it may take place superficial to the glandular structure, in the glandular structure itself, or behind it. Mammary abscesses have, therefore, been divided into superficial, mammary, and post-mammary. The *superficial* form may be limited, or it may spread in the cellular tissue around a considerable portion of the gland; it is not usually attended by such severe symptoms as the other two forms. The *mammary* form may also be limited or diffused; not infrequently, especially in neglected cases, several abscess-cavities exist in the structure of the gland, causing tension and pain, and destroying more or less of its substance, the pus slowly burrowing toward the surface. The local and general symptoms of this condition are often severe.

The *post-mammary* abscess is slow in its progress, and from the position of the pus behind the gland, the latter is pushed forward and projects in a marked manner. In these cases the pus either slowly passes towards the circumference of the breast, generally the lower part of it, and there points at one or more places, or it may gradually work its way through the glandular structure, and point somewhere on the superficial surface over it. It will sometimes happen that more than one of these forms of suppuration exist together, and occasionally both breasts are attacked at the same time or in succession.

The *treatment* of acute mammary inflammation and suppuration consists, in the first instance, in the use of soothing applications in the form of warm fomentations, or lotions of acetate of lead and opium, or belladonna, or poultices. In cases which are the result of lactation, the milk must be drawn off with a breast-pump, and care must be taken to improve the condition of the nipple, and of its ducts, which are sometimes blocked up. It is best to give up suckling the child from the affected breast, but when the mother's health permits, it may be occasionally nursed at the other. In addition to the local treatment, the general health must be carefully attended to, and the action of the bowels promoted by proper medicines. Should portions of the gland remain hardened and enlarged, the affected breast should be supported, and pressure by means of belladonna or other medicated plaster should be made over the enlarged part; in obstinate cases, counter-irritation by the use of iodine or of a blister may be tried if other means fail, and in very chronic cases an antiseptic incision made into the thickened portion will give good results.

When suppuration takes place in connection with the breast, the pus should be evacuated as soon as possible by incision. In superficial abscesses detection of the pus is easy, but in mammary and post-mammary abscesses fluctuation cannot always be recognized until the pus has burrowed its way towards the

superficial surface. It is so essential that these deep abscesses should be early recognized and relieved, that in any case of doubt the aspirator-needle or exploring trocar should be freely used, and, if pus be found, an incision should be made without delay. It is only by early incision, in many cases, that destruction of the breast and surrounding structures, and the formation of sinuses and abscess-cavities, can be prevented. When treating a suppurating breast in which there are several such cavities or sinuses, it is important not only to make a free incision at the most convenient, dependent point, but also to introduce the finger and with it break down any thin walls of partition or any adhesions, so as to convert the whole, if possible, into one cavity. More than one incision may be required in these cases, and the introduction of drainage-tubes will often aid in allowing the pus to escape more freely, and will be useful as a means of injecting the sinuses or cavities with antiseptic or other lotions, so as to promote their healthy condition and healing. Incisions made into the breast for the relief of abscesses or other conditions, should run as much as possible parallel to the duct, that is, from the nipple as a centre, especially when made near this process. Should the abscess not have already burst externally, I would strongly urge, from considerable experience, the importance of employing careful antiseptic measures in its treatment. In cases which are not aseptic, the thorough cleansing and scraping of the walls of the abscess-cavities and sinuses, and the application to them of De Morgan's solution of chloride of zinc (forty grains to the ounce), or of tincture of iodine, will usually promote a healthy action and quicken their contraction and healing. In aggravated cases in which the glandular substance is in great part destroyed, it will sometimes be useful to remove the whole suppurating mass, saving as much of the skin as possible. Patients suffering from mammary abscess who are feeble in health, or who have become weakened and exhausted by irritation and continued suppuration, must be supported by good, nourishing diet, suitable to their condition and powers of digestion. Stimulants are not as a rule required if the food is digested, but they should be given when there is great weakness or difficulty in assimilating ordinary nourishment. Quinine, iron, cod-liver oil, or other tonics, must be prescribed, if the case seems suitable for them, and carriage-exercise in the open air will often aid in improving the health, provided that proper means be taken to prevent any undue exposure to cold.

MILK FISTULÆ.—As a result of abscesses involving the breast, one or more sinuses communicating with the gland-ducts may remain open and allow the milk to escape through them; if such sinuses do not contract and heal, they should be treated by injections of chloride of zinc or iodine; and if this fails to cure them, they should be opened up and drainage-tubes inserted along their whole extent, while at the same time the affected breast must be supported, and, if pressure can be borne, this should be applied over the track of the sinuses; as these contract, the drainage-tubes must be correspondingly shortened from time to time.

CHRONIC INFLAMMATION AND ABSCESS.—As a consequence of acute inflammation—or from some irritation, local, functional, or sympathetic—one or more portions of the breast may become chronically inflamed. In such cases the affected portion is thickened, hard, and sometimes tender to the touch; this condition may remain without much change, it may slowly disappear and the inflammatory products be absorbed, or it may end in the formation of a chronic abscess which may be very slow in its progress, and, if situated in the breast-structure, may be long before it points towards the surface.

Counter-irritation, gentle pressure by means of a belladonna or other plaster, support to the gland, and attention to the health, will generally relieve such swellings. If there be any doubt as to the existence of fluctuation, aspiration will decide the point, and if an abscess be present, it should be opened antiseptically at a convenient point.

LYMPHATIC INFLAMMATION.—Velveau, in his treatise on the diseases of the breast, describes a special form of lymphatic inflammation, and gives the following symptoms as characteristic:—

1. Irregular chills, sometimes a downright shivering fit; a rapid and tumultuous pulse, which is unequal rather than strong; heat of the skin; restlessness; loss of sleep and appetite; and sometimes nausea.

2. In the breast there are pain, great heat, swelling, and red patches irregularly scattered about, coming to a focus in painful spots, more or less raised from the surface.

3. Generally there is a painful state of the axillary glands, and sometimes reddish striae lead from the breast to the armpits. Chaps, excoriations, eczematous eruptions, abrasions of the skin, and all affections of the nipple and areola, are the ordinary causes of lymphatic inflammation of the breast.

The treatment of this condition is that of the other forms of acute inflammation of the breast.

IRRITABLE MAMMA, OR IRRITABLE TUMOR OF THE MAMMA.

In this affection the whole breast, or a portion of it—most frequently the latter—becomes hard and tender to the touch. In some cases the principal symptom is tenderness, without much apparent hardness. The condition is most common in unmarried women, or in married women who have no children, and is often troublesome in regard to its satisfactory treatment. When thickening of the breast-structure exists, the affection may be aggravated by constant examination and handling on the part of the patient, often caused by the fear that the disease is something of a more serious nature. All varieties of the irritable breast are not infrequently attended with some irritation or disorder of the ovarian, uterine, or digestive functions. Some mental excitement or depression is also a common accompaniment of this affection. It is important that cases in which there is induration of the breast-structures should be accurately diagnosed from cases of morbid growth, and experienced surgeons know that the diagnosis between the two is sometimes difficult. The following are the best means of distinguishing these simple indurations:—

1. Inquiry into the history of the case will show that there is no steady increase in size, such as occurs in the case of morbid growths.

2. There is usually much more pain and tenderness than is common in morbid growths.

3. They are not circumscribed, as in the case of simple growths, and their hardness is not as marked as in the case of scirrhus. A special means of distinguishing between the hardness of simple induration and that of scirrhus, is to press the swelling steadily against the ribs, when, in the case of the former, the hardness will be very slight, but in the case of the latter it will be well-marked. Both forms of swelling, when grasped laterally, often feel equally hard; but when pressed backwards, as has been described, a decided difference is recognized.

Mr. Birkett gives as a diagnostic sign in these cases the fact that "pain usually follows the course and distribution of one or more nerves, and that

if these nerves be sought for and pressed upon, as they issue from the thorax, the slightest pressure will induce acute pain, sometimes confined to a single branch distributed to the indurated part, while the rest are unaffected."¹

4. The general condition and temperament of the patient are often significant.

5. Under treatment the symptoms will be relieved in the majority of cases.

Should the diagnosis of this affection be doubtful, the best means of determining its nature is to make a small incision, with antiseptic precautions, into the hard part, and if necessary remove a small portion for microscopic examination.

It is so important that an accurate diagnosis should be made, not only in connection with the treatment of the disease, but in order to relieve the mind of the patient, that I would urge this proceeding in all doubtful cases. If the case be one of simple induration, the incision will probably do good, and if it should turn out to be one of morbid growth, an operation for the removal of the disease will be recommended with more confidence. The treatment of this affection consists in attention to the general health and restoration of any disordered functions, encouragement of the patient by an assurance that the disease is simple in its nature, and the local application of belladonna, a lotion of acetate of lead, or other soothing remedy. If the induration is well marked and the soothing means do not succeed in relieving it, counter-irritation and pressure should be tried, and if the condition still persists and is causing severe symptoms, a free incision into the swelling will be the most likely means of effecting a cure. When the hardness and symptoms continue severe, and when the patient is middle-aged, or older, excision of the swelling would be wise; for such a continued local irritation may undoubtedly develop some form of epithelial cancer.

TUBERCULAR AND SYPHILITIC AFFECTIONS.

The breasts may become involved in connection with *tubercular* affections of the cellular tissue, lymphatic glands, or bones in their neighborhood, and thickening, ulceration, or abscess of their glandular structure may result.

Deposit of tubercle occasionally takes place in the gland itself, as has been described by Velpeau; and such a deposit causes enlargement of the breast or of a portion of it, and this may or may not be followed by the characteristic suppuraton and destruction of tissue. Such an affection requires the general and local treatment which is found most useful in tuberculosis.

Syphilitic affections of the skin, cellular tissue, periosteum, and bone in the neighborhood of the breasts, may involve those organs, and cases of syphilitic enlargement of the breasts themselves have been recorded by Dr. C. Ambrosoli.² This form of enlargement consists in a more or less general hypertrophy of the gland, with uniform induration of its tissues.

The affection occurs in syphilitic patients, sometimes attacking both breasts, sometimes only one, usually at the end of the secondary or at the commencement of the tertiary period. The characteristics of this syphilitic enlargement are, that the hardness is uniform, smooth, and not very painful, and that it yields to antisypilitic treatment. The use of iodide of potassium internally, and, if this fails, of mercury in small doses, together with gentle counter-irritation and pressure, constitutes the treatment of these cases.

¹ Holmes, Principles and Practice of Surgery, p. 825.

² Ranking's Half-yearly Abstract, vol. xlii., 1865.

PARASITES AFFECTING THE MAMMA.

Dr. Haussmann, of Berlin,¹ has given an important account of the parasites met with in the breast. The only animal parasite the presence of which in the breast he has been able to authenticate, is the *Echinococcus*. From an examination of the reported cases, Dr. Haussmann is of opinion that the cyst caused by this parasite never involves the nipple or its immediate neighborhood, but that it may occur in any other part of the gland. There may be a single cyst, or a cyst containing from one to four or five others; a multilocular hydatid cyst has never been reported as met with in these organs. Landau, of Breslau,² records a case in which the cyst communicated through the ribs and intercostal muscles with the cavity of the chest or abdomen. The symptoms of this affection are a smooth and fluctuating swelling of slow growth, causing usually no symptoms except a little pain in the axilla and arm of the affected side. This rare condition may simulate a simple serous cyst of the gland, but aspiration or tapping would reveal the characteristic fluid and contents, in the case of an hydatid cyst. Inflammation and suppuration in the tissues outside the cyst-wall may take place, and this may be followed by a bursting of the cyst externally, escape of its contents, and a spontaneous and gradual cure of the disease.

The treatment of this condition is to make a free incision into the cyst, and to introduce a drainage-tube and retain it for some time. Should this not cure, the cyst may be excised; but from my experience of the treatment of hydatid cysts in other external parts of the body, I am disposed to think that the more simple treatment will usually suffice.

AFFECTIONS OF THE NIPPLE.

INFLAMMATION may attack the nipples and surrounding skin, causing excoriation, ulceration, or fissure. This condition is most commonly met with in connection with pregnancy and lactation, but it may occur from any form of local irritation. It may give rise to much painful smarting and suffering, and in severe cases to general disturbance, and it is especially troublesome in the case of nursing women. The ulcers or fissures may be deep, and may destroy the skin so as to leave the nipple only attached to the breast by the lacteal ducts. Obstruction of these ducts may result, and may lead to the formation of abscesses.

Treatment.—In cases of simple irritation and excoriation, the parts should be kept clean by carefully washing them with warm water and soap, and some astringent lotion should be applied. Cologne-water, spirit of wine, and strong infusions of tea, catechu, or other astringents, are advised for this purpose. A mixture of gr. x of nitrate of lead to ʒj of glycerine has also been suggested. Playfair advises equal parts of sulphurous acid and glycerine of tannin, with twice the quantity of water; and Leishman, an ointment consisting of gr. iij of tannic acid, ʒss of glycerine, and ʒj of spermaceti ointment. When the fissures are deep and painful, touching them with solid nitrate of silver, and leaving the resulting scab uninterfered with until it loosens and falls off, is one of the best methods of treatment. If suckling causes great suffering and interferes with the healing of the fissures, a zinc nipple-shield may be used, or suckling may be given up altogether on the affected side. It is important to

¹ Med. Times and Gazette, vol. ii. 1874.

² Archiv für Gynäkologie, Bd. viii. 1875.

note that if the breast is being used for nursing, all applications of a poisonous nature must be carefully washed off before the child is put to the nipple.

RETRACTED NIPPLES.—The nipples may be small and retracted congenitally, or owing to the pressure of stays or other portions of dress, or to contractions of the breast-structure from inflammatory causes or the presence of tumors. Such a condition may cause much trouble in connection with suckling, and by leading to obstruction of the lacteal ducts. When due to the first two causes mentioned, it may sometimes be relieved by regularly drawing out the nipple with the fingers or sucking-glasses. The application of a shield, with tube attached, will occasionally assist in allowing the child to be nursed.

TUMORS OF THE BREAST.

All practical surgeons are aware of the difficulty, in the present state of pathological knowledge, of making a correct classification of tumors. In the case of the breast, as in the case of other organs, tumors affecting it, which were once considered to be simple or benign in their characters, are now known to be as malignant in their tendencies as are the true cancers. It is unfortunate, too, that, owing to defective pathological study, different terms have been applied to the same kind of growth, while on the other hand growths of an entirely different structure have been classed under the same term, owing to their having some resemblance to one another in their external characteristics.

The case appears to stand thus: Pathologists have, by improved microscopic study and other research, determined that tumors formerly supposed to be identical, vary much in their development, structure, and tendencies; but practical experience is not yet sufficient to enable the diagnostic symptoms and behavior of all these varieties to be accurately described by mere clinical study and external examination. Under these circumstances, an attempt can only be made to study the subject of tumors of the breast in their pathological and clinical aspects, as far as present experience exists. In order to do this as practically as possible, it is proposed to employ the terms *simple* and *malignant*, and to classify under these heads the tumors that affect the breasts. I am aware that this classification is imperfect, and that tumors which may be considered of a *doubtful* nature must be included under one or other of these heads; but the term “semi-malignant,” which is sometimes used, scarcely expresses the true behavior of such growths.

Professor S. W. Gross, in his recent and valuable work, a study of which has been most interesting and useful to me, suggests the following combined genetic and anatomical classification of tumors of the breast:—

(A)

1. Neoplasms derived from the periglandular connective, and constituted by connective tissue or its equivalent, of which two divisions may be made, namely:—

(a) Those which represent perfected or matured connective tissues, and may, therefore, be called typical. These comprise fibroma, or fibrous tumor; myxoma, or mucous tumor; lipoma, or fatty tumor; and chondroma, or cartilaginous tumor.

(b) The second division includes those neoplasms which represent embryonic, unripe, or transitional connective tissue, and may be termed atypical. It is limited to the genus sarcoma.

2. Neoplasms which proceed from the secreting elements, and are composed of epithelium. Of these, adenoma, or glandular tumor, is a typical epithelial growth, while carcinoma is an atypical epithelial formation.

3. Neoplasms which are derived from and are constituted by higher structures.

These are, first, angioma, or a tumor consisting of bloodvessels; and, secondly, neuroma, or a growth made up of nerves.

(B)

Cysts, which include the formations due to obstructions of the ducts and the accumulation of the secretion of the lacteal glands, and cysts of new formation, including echinococci.

Dr. Gross also expresses the opinion that—

The development of the neoplasms of the breast is connected with the changed proportions of the component tissues of the breast at different periods of life, and that the condition of the tissue is, as a rule, indicated by the age of the patient.

He further remarks that—

The non-carcinomatous growths occur on an average at the thirty-third year; only 30.37 per cent. develop after the age of forty, when the physiological life of the mamma is beginning to be impaired; 15.22 per cent. appear before the twentieth year; and 5.18 per cent. are met with before the establishment of menstruation. Previous to the age of forty, or during the structural perfection of the gland, or when the proportions existing between the epithelial and connective-tissue constituents is normal, fibromata and sarcomata are the most common neoplasms.

From the same statistics he also infers that—

Structural perfection of the mamma renders it most obnoxious to fibroma, sarcoma, and adenoma, while atrophy or decay predisposes it to myxoma and carcinoma.

I. SIMPLE TUMORS.

FATTY, VASCULAR, NERVOUS, AND CARTILAGINOUS TUMORS.—*Fatty tumors* are occasionally met with in the cellular tissue round the breast, but they do not affect the breast itself. *Vascular tumors*, affecting the breast, have been recorded by Bryant, Image,¹ and Langenbeck.² Two cases of *neuroma* in the breast have been reported by Tripier.³ A few cases of *cartilaginous tumor* of the breast are also on record. The best recorded case is that of Dr. Lange.⁴ The tumor was removed from the breast of a woman, 51 years of age, and, according to Dr. Lange's account, "consisted of true cartilaginous and osseous tissue, the former mostly in its variety as hyaline cartilage. One large, roundish division, about one and a half inches in diameter, contained a large, bony nucleus. Otherwise the tumor consisted of a number of smaller, roundish divisions, separated from each other by strong layers of fibrous tissue, and showing partly glandular structure with cartilaginous nuclei scattered."

These various tumors do not require any special remarks in regard to their treatment. Should they, from their symptoms or bulk, cause inconvenience, they must be dealt with according to the ordinary principles of surgery.

CYSTIC TUMORS.—These may be divided into (1) Single Cysts; (2) Multiple Cysts. Cysts are also met with which contain solid growths in their interior—the so-called "sero-cystic" tumor of Brodie, the "proliferous cyst" of Paget,

¹ Med.-Chir. Trans., vol. xxx.

² Nosologie und Therapie der chir. Krankheiten, Bd. v. S. 83.

³ Dict. Encyclop. des Sciences Méd., 2e série, t. iv. p. 408.

⁴ Med. Record, 1881.

and the "cystoid-adenocoele" of Birkett—but these may be more properly classified in reference to the special forms of growth which are contained in them.

(1) *Single Cysts*.—Single cysts may occur at any part of the breast, but are most common in the region of the nipple, or in the substance of the gland near it. The contents of these cysts vary: they may consist of clear serum, of serum mixed with blood, or of a fluid, brown or yellow with scales of cholesterin. I have occasionally seen the fluid of a greenish color. The walls of the cyst are generally thin, and occasionally they undergo calcification. These cysts may occur in married or unmarried women, but they are more frequent in the former. Their size varies from that of a small marble to that of a large orange. One case is recorded, of a cyst from which nine pounds of serum were evacuated. A very common size is that of a small walnut. Inflammation and suppuration of these cysts have been recorded, but they are rare.

Diagnosis.—There is a circumscribed swelling, regular in shape, fluctuating, and unattended with any inflammatory signs or any marked hardness of the surrounding breast-structure. The feeling of fluctuation is not always distinct, as the cyst may be tense, forming a firm and somewhat elastic tumor. These cysts may be superficial, and in such cases the skin becomes gradually thinned over them, so that the swelling can be seen to be more or less transparent. In some cases there is a discharge from the nipple in connection with this condition. As it is sometimes not easy to distinguish these cysts from solid growths, a fine trocar or aspirator-needle may be introduced in order to decide the question. The tendency of these cysts is to increase slowly in size if not interfered with; occasionally, however, they increase rapidly.

Treatment.—Puncture and evacuation of the contents of the cyst, and afterwards pressure over its cavity. If there should be any thickening of the tissues round the cyst, the application of a blister over the swelling is usually beneficial.

If simple puncture and counter-irritation fail to cure the cyst, it is best treated by means of a small incision with antiseptic precautions, and the introduction of a drainage-tube. In puncturing these cysts it is important to fix them with the fingers, because, when movable and tense, the trocar or needle may fail to enter the cavity if this precaution be not adopted. Excision of a single cyst is rarely required.

(2) *Multiple Cysts*.—Two varieties of these are met with: one in which numerous cysts varying in size are scattered through the substance of the gland, and the other in which two, three, or more large cysts exist, and are grouped together. In the former, there is usually some thickening of the breast-structure in the neighborhood of the cysts; and in the latter, the glandular structure has usually partially or wholly disappeared. The contents of multiple cysts vary, and are similar to those met with in single cysts.

Diagnosis.—There is a nodulated, irregular condition of the breast—the nodules being felt as small, firm, elastic swellings, in which, on careful manipulation, fluctuation can usually be detected—with some thickening and knotting of the breast structure. Or there is a swelling, irregular in shape, with distinct and separate fluctuation at more than one point, and more or less absence of the gland substance. There is sometimes a discharge from the nipple, and in some cases the skin is thinned, and shows transparency.

As in the case of the single cyst, the tendency of the multiple cyst is to increase in size, and it occasionally becomes inflamed and suppurates.

Treatment.—In the case of a tumor composed of two or three large cysts, and confined to one portion of the breast, an attempt should be made to cause their obliteration by incision and careful drainage; but when the cysts

involve the greater portion of the breast, or are scattered through its whole substance, excision of the entire breast is the only satisfactory remedy. If the cysts are small, not increasing in size, and not causing any annoyance, operative interference may be delayed until they become troublesome.

ADENOMATA AND FIBROMATA.—These growths, which are composed of connective tissue in a more or less perfect or embryonic state, may be classed together, because, as a clinical fact, it is not usually possible to distinguish them from one another until they have been subjected to microscopic examination.

A purely *adenoid tumor* is of very rare occurrence, and may be described as a growth composed of fully developed glandular tissue, such as is met with in the physiologically active mamma.

The *fibroma* may be described as a tumor mainly composed of fibrous tissue in a more or less developed state, and containing in the majority of instances some adenoid or glandular structure in its substance; hence such tumors have been termed by some, fibro-adenomata. These tumors may be considered innocent in their nature, and are separated from the breast-structure by a well-marked fibrous capsule. Two varieties are met with: first, the solid; second, the cystic. The solid tumor is met with as a circumscribed, firm, elastic swelling, usually lobulated, but with the lobules sometimes so small that the tumor feels smooth and regular. It is most frequently situated superficially, below the nipple, or at the axillary margin of the breast; but it also occurs in the substance of the gland itself; and I have met with two cases in which the tumor formed a prominent swelling behind the breast. Occasionally these tumors have been found to be pedunculated; and, wherever situated, their capsule is more or less adherent to the breast-structure. Their growth is usually slow, but it may be somewhat rapid, especially in the cystic form; and their size varies from that of a bean to that of a child's head. It has occasionally been observed that these tumors increase temporarily in size during menstruation and pregnancy. There can be no doubt that they may become smaller, and that they may even disappear spontaneously.

According to my experience, these tumors are most frequently met with in young adults, but they may occur at any age, from twelve to sixty. They are usually single, but multiple growths are sometimes met with. In the cystic form the growth is usually distinctly lobulated, has a tendency to grow more quickly than in the solid form, and is firm to the feel at some points and fluctuating at others. Growths varying in form and color spring from the inner wall of the cyst, and in not a few cases there is some discharge from the nipple. This variety of the growth is more frequently met with at a later age than is the case with the more solid variety. These tumors occasionally inflame, suppurate, and fungate, more particularly in the cystic form. A large, fungating, solid fibroma has come under my observation, but the ulceration and fungation in this case were the result of a quack application. Calcareous and other changes also affect these tumors, and I have removed a fibroma which had become almost entirely converted into a calcareous mass.

Diagnosis of the Solid Form.—A firm, elastic, circumscribed, and more or less lobulated tumor is observed, usually of slow growth, having the skin and other tissues over it freely movable, and showing no signs of discoloration. As has already been mentioned, it is common to find these tumors adherent at one point, usually in their deeper relations to the breast-structure.

The *cystic form* constitutes a tumor distinctly lobulated, varying in degrees of solidity and fluctuation, circumscribed, and in some instances attended

with discharge from the nipple. According to Gross, in one of every seven cases there is discharge from the nipple, and there is a tendency to fungate in the same proportion.

Treatment.—If causing irritation or much mental distress, or if increasing rapidly in size, excision of the tumor alone is the best treatment. Pressure by means of pads, and the application of plasters, have been employed, but without much good resulting; and, as these tumors are movable, it is very difficult to apply direct and continuous pressure to them. If the growth is large and the breast structure atrophied, excision of the entire gland and tumor will be the most satisfactory proceeding. Although these tumors may be considered, as a rule, innocent in their nature, they do occasionally soften and enlarge, and simulate malignant growths in their progress. It has also been occasionally observed, that, after their removal, a secondary growth with malignant tendencies has been developed in the situation of the original tumor. The most probable explanation of the latter cases is that referred to by Paget, who considers that these secondary tumors are really cancers developed independently, and in some instances as the result of the local irritation produced in connection with the original growth.

The pure adenoma occasionally recurs after operation, but usually locally, as in the neighboring glands. Secondary growths must be removed, should the condition of the patient warrant an operation.

II. MALIGNANT TUMORS.

SARCOMATA.—Although there is a difference of opinion as to the degree of malignancy of these tumors, the most recent investigations tend to prove that many of them are as serious in their characteristics as the true cancers; and that although others are not so serious in their nature, they can scarcely be termed benign. The whole subject of these tumors, as they occur in the breast, is in a somewhat unsettled state, but Dr. S. W. Gross has brought together many interesting and important facts, which will assist in clearing up the matter, and in placing our knowledge on a more practical basis.

The sarcomata which affect the breast may be solid or cystic, and their structure may be *round-celled*, *spindle-celled*, or *giant-celled*. In some instances—about one-third of all sarcomata, according to Gross, and more especially in the spindle-celled—glandular or adenoid structure exists. The inter-cellular substance in the various sarcomata differs, and leads to variations in the pathology and consistence of these growths. Fatty, cystoid, calcareous, and other changes likewise take place, and, like other tumors, they are also liable to become inflamed and to suppurate.

The spindle-celled variety is by far the most common. Out of 60 cases of sarcoma of the breast collected by Gross, 45 were spindle-celled; and out of 16 cases which came under the notice of the same surgeon, 11 were of this character. According to the same author, six-tenths of all sarcomata in this region are cystic, and in one out of every seven of these there is discharge from the nipple.

Sarcomata are, in the large majority of cases, single in the first instance, and they are usually of more rapid growth than fibromata; but there appears to be considerable diversity in this respect, as some tumors have been known to remain of small size for several years, while in other instances a tumor has grown to the weight of several pounds in a few months. It has also been observed that these tumors are sometimes subject to a sudden and rapid increase; and Gross notices the fact that during the active growth of sarcomata, there may be elevation of the general temperature.

Diagnosis.—As these growths are usually encapsuled, and form circumscribed tumors in their early stage, they are not easily distinguished from the fibromata, but their progress and future behavior will in time reveal their true nature. Their shape is rounded or oval, with more or less lobulation, and their feel is firm in some cases (the spindle-celled), soft and elastic in others (the round-celled); but alteration in structure, or degeneration, may cause either of these varieties to be modified as regards its consistence. In the cystic variety, the growth is partly firm and partly elastic to the feel, and in the majority of cases occurs at an earlier age than in the solid form, and, more particularly in the case of cystic, spindle-celled growths. Sarcomata may or may not be attached to the breast structure; frequently they push it aside, or cause it to atrophy. The skin over these growths remains movable and unaffected for a time, but when the tumor increases the skin may become thin, and ulcerate. As the growth progresses it may not only involve the skin, but may fungate, infiltrate the surrounding textures, and affect the internal organs. In connection with the diagnosis of these growths, I think it well to give the following quotation from the work of Dr. S. W. Gross, already referred to:—¹

The diagnosis of small, slowly increasing, fibrous sarcomata is by no means easy, as they are very liable to be confounded with fibromata, particularly when they arise at the circumference of the mamma. A tumor, however, of soft, elastic, apparently fluctuating consistence, which attains the volume of an adult head in a few months, can scarcely be anything else than a small-celled sarcoma. On the whole, the diagnosis is based upon their indolent origin, mobility, central situation, elastic or unequal consistence, lobulated outline, rapid increase, large dimensions for the period of their existence, freedom from lymphatic involvement, and marked tendency to ulcerate; upon the not infrequent discoloration of the skin, enlargement of the subcutaneous veins, and, possibly, elevation of temperature; upon the suffering which they awaken late in the disease; and upon their greatest frequency after the thirty-fifth year. Between the solid and cystic varieties there are certain distinctions which are useful in establishing a differential diagnosis. The former develop at about the thirty-seventh year; the skin is discolored in 16 per cent. and adherent in 12 per cent.; the veins are dilated in 8 per cent.; there is no discharge from the nipple; pain is met with in 30 per cent., but is slight; the tumor ulcerates in 12 per cent., and is characterized by malignant features in 77 per cent. of all instances. Cystic sarcoma starts at the thirty-third year, it grows more rapidly than the solid variety, and its increase is often sudden after having remained stationary or advanced slowly for some time. Now and then, after evacuation of the fluid of the superficial cysts, their solid contents can be detected by manipulation. The consistence of cystic sarcomata is, as a rule, unequal, and they are more largely lobulated than those of the former variety. The skin is discolored in 34 per cent., being of a bluish tint in one-third of all cases over the most prominent cysts; and it is adherent in 11 per cent.; the veins are enlarged in 25 per cent.; the nipple is retracted in 5.71 per cent., and discharges fluid in 14.28 per cent.; ulceration occurs in 34.28 per cent.; pain is experienced in 78 per cent., and it is usually harassing, while the disease is malignant in 64 per cent. of all cases.

After the removal of these growths recurrence takes place locally, not as frequently as in cancer, but more frequently than cancer in the internal organs. Gross states "that mammary sarcoma recurs locally in 61.53 per cent. of all instances, and that it gives rise to secondary deposits in distant organs in 57.14 per cent." "In carcinoma, on the other hand, 88.35 per cent. of the local recurrences are met with in the first year, while only 50 per cent. of the cancers affect distant parts."

Treatment.—Early and free removal of the tumor and surrounding textures, and, if the tumor is large or seriously involving the breast-structure, excision

¹ Op. cit., p. 99.

of the entire gland along with the growth. Recurrent growths should be at once removed if no visceral complication be detected; for such removal certainly prolongs life, and lessens the risk of further infiltration or involvement of internal organs.

CARCINOMATA.—Considering cancer as a new formation, generally now described as an atypic, epithelial growth, which tends to infiltrate the tissue in which it originates, to involve the surrounding textures, and to affect the lymphatic glands and internal organs, it may be held that the varieties of cancer, and the modifications met with in some of them, depend upon the conditions of their cell-elements, and upon the character and condition of the stroma in which the cells are contained. There is a considerable difference with regard to the rapidity of progress, and the date and nature of involvement of surrounding tissues, lymphatic glands, and internal organs, in cases of cancer of the breast: and there is also a considerable difference in connection with the occurrence of general cachexia in patients suffering from this disease. In some instances cachexia is from the first well marked, while in others it occurs only late in the progress of the malady. For practical purposes the varieties of cancer affecting the breast may be divided into *scirrhus*, or hard cancer, and *encephaloid*, or soft cancer. *Colloid* cancer has, in rare cases, been met with in the breast as a primary growth, and it occasionally occurs also as a form of degeneration in other tumors. When met with as a primary growth it is not at first easily distinguished from other slow-growing tumors, unless there is an opportunity of examining its structure microscopically. Clinically, it is characterized by its firm consistence, chronic nature, and slowness to involve lymphatic glands, surrounding tissues, or internal organs. It has been met with at the age of 28, and as late as 66 years—the average being 45 years (Gross)—and it does not usually attain a large size. The frequency of the different varieties of cancer in the breast, according to the cases tabulated by Prof. Gross and Dr. Henry, may be stated as follows:—

Out of 100 cases there were of:—

Ordinary scirrhus	.	.	.	.	.	.	.	.	77
Simple carcinoma	.	.	.	.	.	.	.	.	11
Atrophic scirrhus	.	.	.	.	.	.	.	.	7
Encephaloid cancer	.	.	.	.	.	.	.	.	5

Of 59 cases of cancer of the breast reported by J. Mason Warren,¹ there were of scirrhus 54 (one patient a male), and of encephaloid only five.

Paget thinks the proportion, in Great Britain, not greater than 5 of encephaloid to 95 of scirrhus. M. Lebert² states that, in France, about one-fifth of the cancers of the breast are soft and encephaloid.

The time of life during which patients may suffer from cancer of the breast is from 28 to 84: the majority of cases occur between 40 and 50. Out of 160 cases observed by Nunn,³ 36.87 per cent. were between 40 and 50. Birkett gives 193 out of 458 cases between the ages of 40 and 50. In a series of 276 cases observed by Paget, there were patients:—

Between 20 and 30 years of age	.	.	.	.	.	.	.	5
“ 30 “ 40 “	.	.	.	.	.	.	.	41
“ 40 “ 50 “	.	.	.	.	.	.	.	122
“ 50 “ 60 “	.	.	.	.	.	.	.	65
“ 60 “ 70 “	.	.	.	.	.	.	.	35
“ 70 “ 80 “	.	.	.	.	.	.	.	8

¹ Surgical Observations.

² Des Maladies Cancéreuses.

³ Cancer of the Breast.

It will be seen by these statistics, that cancer of the breast is rare before 30. It has been met with at the age of 28 in several instances, and I have myself met with one case of scirrhus at this age. Henry, quoted by Gross, records a case at 21. Mr. Sibley records as the earliest age, 26, and as the latest, 84. I have met with and operated upon 2 patients at 84 years of age; and Mr. Bryant refers to a case of one year's standing in a patient 96 years of age; but the disease is not common after 70. [The Editor saw some years since, with Dr. Albert H. Smith, of Philadelphia, a case of atrophic scirrhus in the breast of a patient aged 89.]

In regard to the effect of marriage, lactation, and other conditions connected with the generative functions, on production of cancer of the breast, it would appear that the disease is more common in the married, and in those having children. Of 160 patients referred to by Num, 22 were single, and had no children; 138 were married, of whom 51 were sterile, and 87 had children, having on an average, 5.5 children. Baker¹ gives a table of 260 cases of cancer of the breast, in which there were of:—

Single women	. . . . .	23.0 per cent
Married women	. . . . .	72.4 “
Widows	. . . . .	4.6 “

Gross notes that of 688 women, 607, or 88.22 per cent., were, or had been, married, and 81, or 11.77 per cent. were single. Of 435 women, 365, or 83.91 per cent., had borne children; and of these nearly nine-tenths had had more than one child, while 70, or 16.09 per cent., were barren.

In regard to the influence of menstruation, Paget gives a table of 400 cases as follows:—

Ages.	Cessation of Menstruation.	First observation of the Cancer.
Below 35	. . . . . 9	. . . . . 36
35 to 40	. . . . . 51	. . . . . 62
40 to 45	. . . . . 140	. . . . . 78
45 to 50	. . . . . 159	. . . . . 101
Above 50	. . . . . 41	. . . . . 123

It would serve no practical use, in the present state of our knowledge, to discuss here the *causation* of cancer, but it is enough to consider that the female breast is one of the organs in the body which appears to be favorable for the development of this disease, and that prolonged local irritation or injury, in not a few cases, acts as an excitant of its development. Paget found that out of 91 patients only 16 ascribed the cancer to injury or any such local cause. Dr. Gross states that in 23 out of 270 cases analyzed by Winwarter and himself, the disease was ascribable to traumatism—such as blows and contusions, and that in 5 of 370 cases collected by Oldekop and himself, it was preceded by eczema or psoriasis of the nipple, while it started from lumps or chronic indurations left by puerperal mastitis in 30, or 8.21 per cent. of the 365 women who had borne children. The association of eczema of the nipple and of the skin around it with the production of cancer of the breast, has been brought under notice by Sir James Paget,² Mr. Butlin,³ Mr. Henry Morris,⁴ Dr. Thin,⁵ and others. From a consideration of the recorded cases of this condition, it would appear that in some instances there has been a history of from five to six years' local irritation before the development of the cancer, while in other cases the cancer has been developed within two years from the

¹ Med.-Chir. Trans., vol. xlv.

² St. Bartholomew's Hospital Reports, vol. x. 1874.

³ Med.-Chir. Trans., vols. lx. and lxiv. See, also, Vol. I., page 910, *supra*.

⁴ Med.-Chir. Trans., vol. lxiii.

⁵ Med.-Chir. Trans., vol. lix.

first appearance of the eczema. In one case reported by Mr. Morris, the local irritation amounted to ulceration. In some of the reported cases there has been a distinct portion of healthy tissue between the affected skin and the cancer in the gland, but in others the two conditions have been continuous. These cases have been met with at the ages of 33, 40, and 60 years, and at periods between those ages.¹

Hereditary tendency also influences, but not to a great extent, the development of cancer in the breast. According to Nunn, in 160 cases, cancer had been treated among the relations in 47 cases, or 29.3 per cent. Of 389 cases quoted by Gross, 40, or 1 in every 9.72, stated that cancer had occurred in some of their ancestors.

The hereditary history of phthisis has also been thought to influence the occurrence of cancer; Nunn mentions that out of 160 cases, phthisis was traced among relatives in 36. Sibley found 48 instances of the occurrence of phthisis in 130 cases.

Mr. Nunn has pointed out an interesting fact in connection with the longevity of the families of patients suffering from cancer of the breast. In 169 cases observed by him, the average age of the fathers was 62.25, the average of the mothers 61.53; 106 patients had grandparents who had lived to be more than 70 years old; 62 had parents who had lived to be more than 80 years old; 15 had grandparents known to have lived over 90 years.

It has also been observed that the majority of patients are in good health when the cancer first develops itself. Paget found that in 91 cases no less than 66 presented the characters of robust, or at least good, health, 9 were of uncertain or moderately good health, and only 16 were sickly or feeble. Baker also observed that only 5.2 per cent. of patients suffering from scirrhus of the breast were in bad health when the disease was first observed. Gross says that out of 189 patients, in whom the general condition is mentioned, 97, or 51 per cent., were in robust health, 34, or 18 per cent., were in good health, 37, or 19 per cent., were pale and thin, and 21, or 11 per cent., were decidedly broken down from the effects of the disease.

The *progress and duration of cancer of the breast*, if uninterfered with by operation, vary considerably in different cases, and also vary in the two forms of the disease. According to Paget, the average duration of scirrhus is a little more than four years, while in an encephaloid cancer it is rather more than two years. In 61 cases quoted by this surgeon:—

7	died in between	.	.	.	.	.	.	6 and 12 months.
7	" "	.	.	.	.	.	.	12 " 18 "
8	" "	.	.	.	.	.	.	18 " 24 "
10	" "	.	.	.	.	.	.	24 " 30 "
2	" "	.	.	.	.	.	.	30 " 36 "
12	" "	.	.	.	.	.	.	3 " 4 years.
6	" "	.	.	.	.	.	.	4 " 6 "
3	" "	.	.	.	.	.	.	6 " 8 "
1	" "	.	.	.	.	.	.	8 " 10 "
5	" "	.	.	.	.	.	.	10 " 20 "

Sibley makes the average 32 months, and Baker 43 months.

Cases of cancer of the breast have been known to run a rapid course of a few weeks or months, but, on the other hand, some varieties of scirrhus will exist for several years; cases have been recorded of 10, 15, and 20 years' duration, without the disease progressing.

When the disease occurs during pregnancy or lactation it sometimes runs a very rapid course. I once operated upon a mother and daughter for scirrhus

¹ See Plate XI., Vol. I., page 910, *supra*.

of the breast, both within two weeks; the daughter was nursing when the disease first showed itself, and in her case its progress was much more rapid than in the case of her mother, and further, the disease returned in the daughter's breast much earlier than in the mother's. During the progress of the disease, changes may take place in the tumor itself, and the cancer sooner or later involves the surrounding textures, and affects the lymphatic glands and perhaps the internal organs. The changes which affect the substance of a cancer of the breast are those met with in all cancers, and consist of fatty and granular degeneration of the cells, cystoid degeneration, occasionally calcareous degeneration, inflammation, ulceration, suppuration, sloughing, and fungation. In addition to these, a scirrhus cancer may undergo atrophy, or shrink, as will be more particularly referred to in the consideration of this form of the disease.

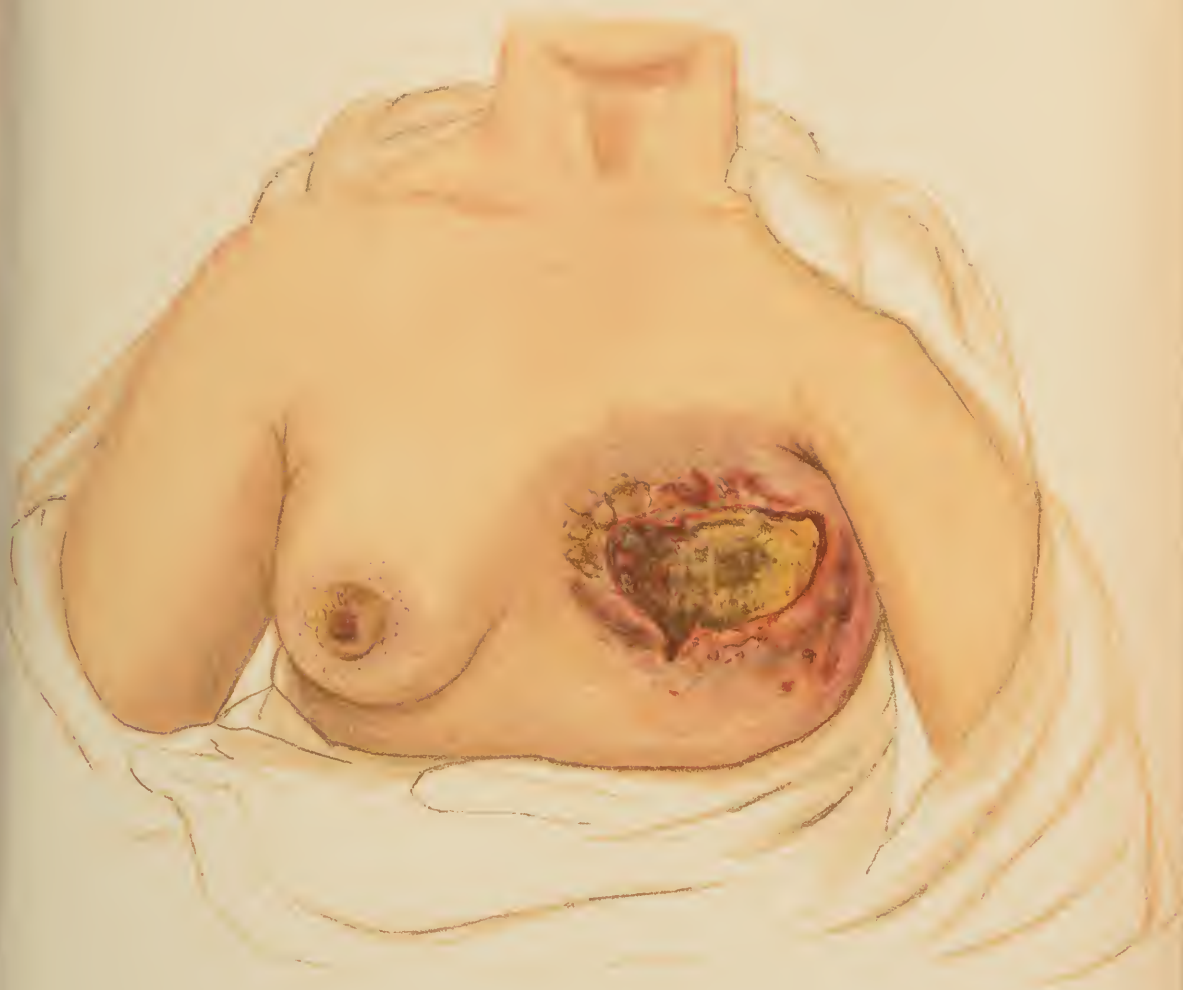
In the progress of cancer of the breast, the lymphatic glands in the axilla and cervical region become sooner or later affected, in the majority of cases; the surrounding skin may at any time become affected with cancer, either in the form of nodular deposits, or, more rarely, a flat, hard thickening of its substance. Adhesion, discoloration, thinning, and ulceration or sloughing of this same tissue, are also not uncommon, and less frequently the muscles become infiltrated with cancer, while in rare instances the other breast may become involved. (Plate XXXII.) Certain of the internal organs and structures are liable to become the seat of secondary growths, and among the chief of these are the lungs, liver, and pleura. From an interesting series of 128 post-mortem examinations of cases of cancer of the breast, collected by Gross, we note that the axillary glands were affected in 89.4 per cent.,

Other glands in	23.43 per cent.
Pleura	23.43 "
Lung	21.87 "
Liver	42.96 "

Numm also gives a table of 21 post-mortem examinations of cases of cancer of the breast, which likewise shows the frequency with which the liver, lungs, and pleura become involved. More rarely the stomach, ovaries, kidneys, bones, brain, and occasionally other internal organs or tissues, are affected.

The effect of operative interference on the progress of cancer of the breast may be here briefly noticed. Experience proves that operative treatment, when the entire disease can be removed, tends to prolong life, and that even in acute cases of the disease an operation may for a time, although it may be for only a very short time, check its progress. Although therefore the removal of a cancerous breast cannot be considered a very satisfactory proceeding as regards its results in curing the disease, there is sufficient testimony to encourage a resort to the operation in properly selected cases; and most surgeons can, amongst many failures, record instances in which patients have remained free from a return of the disease for five, ten, or more years. It must also be remembered that the removal of a cancerous breast will frequently take away, at least for a time, a painful and weakening complaint, and will do much to relieve the sad mental distress which such a disease produces.

SCIRRHUS CANCER.—Varieties of this form of cancer have been described under the terms "simple carcinoma," "fibroso-medullary cancer," and "atrophic" or "chronic cancer." These varieties are merely the result of differences in the amount of cells and stroma in the tumor, or of degeneration of the cell-element, with contraction of the stroma in which the cells are imbedded. These variations lead to certain differences in the



Carcinoma of both breasts; ulcerated on the left side; on the right side showing lardaceous appearance of skin.

(From a Patient in the Hospital of the University of Pennsylvania.)

appearance, consistence, and progress of the growths, but they all possess the general characteristics of cancer.

Symptoms, Diagnosis, and Progress.—In the early stage of the disease, the most common condition is that of a hard, irregular, more or less circumscribed lump in the breast structure; this lump is not usually large, but in some cases of acute disease it may grow rapidly. The situation of the lump varies; it is most common towards the outer border of the breast, not far from the nipple and a little above it, but it also occurs at other points in the gland. There may or may not be adhesion of the skin with a corresponding depression, and the nipple may or may not be drawn down and retracted. Out of 100 cases, Gross found retraction of the nipple in 52. The neighboring lymphatic glands may or may not be affected. The hardness varies in degree according to the relative proportions of cell-element and stroma, but in most instances it is well marked and stony in character. This symptom is best detected by pressing the tumor backwards against the ribs, standing behind the patient while doing this. Occasionally, some part of the tumor may be softer, owing to the presence of cysts. The amount of irregularity also varies; in some instances the swelling is distinctly nodular, while in others it is smoother to the touch. The outline differs in different cases: the growth may feel circumscribed, except at its point of connection with the breast-structure, but in other instances the cancerous material may be infiltrated into the surrounding textures, and the margins of the growth may be consequently ill-defined. The fixedness of a scirrhus depends upon the amount of its infiltration into the breast-structure, and upon the adhesion and involvement of skin, fascia, and muscles. In its early stage, the growth may be freely movable except at the point of its attachment to the gland, but in its progress this mobility may become very limited.

As a rule, a scirrhus growth is not painful to touch, although in a sensitive patient even gentle pressure may be complained of. In many cases the patient suffers from pain shooting through the breast, and this is most common in acute instances of the disease. The whole affected breast usually presents some alteration in appearance, size, and position; and occasionally discharges, tinged with blood, run from the nipple. These are the symptoms most frequently met with in connection with scirrhus of the breast, but there is much difference in regard to the rapidity and nature of its progress. In cases in which the cancer becomes infiltrated into the greater part of the breast-structure, there is general enlargement and induration of the breast, and in well-marked examples of the atrophic form the gland-structure in great part disappears, and the growth and adherent textures resemble a depressed, hard, and contracted cicatrix.¹

In a few instances (1 in every 48, according to Gross), the disease is met with in the form of distinct nodules. As an assistance to diagnosis, the age of the patient may be considered: reference has already been made to the fact that the largest number of cases occur between the ages of 40 and 50. Constitutional cachexia occurs at varying times after the first appearance of the disease. In a few instances it is present almost from the first, but in the majority it only becomes marked during the progress of the disease.

By means of the symptoms mentioned, scirrhus of the breast can usually be diagnosed, but occasionally other conditions, and more particularly chronic inflammatory induration of the breast-structure or portions of it, and chronic abscesses or cysts with induration of surrounding textures, simulate this form of cancer very closely. Should general and local treatment not speedily relieve these conditions, and the case be of doubtful nature, no time should

¹ See Plate XII., Vol. I., page 919.

be lost in making an exploratory, antiseptic incision, so as to determine the true character of the swelling.

If scirrhus of the breast be not interfered with by operation, it progresses more or less rapidly. In the acute form of the disease its progress may be very quick, and it may run its course and cause death in a few months, more especially when it attacks a patient who is pregnant or nursing at the time. Billroth relates a case in which death took place six weeks after the first appearance of the disease, and in which the liver, kidneys, omentum, pericardium, and thyroid gland contained secondary deposits. This however must be considered an exceptional case. It has also been noted by Paget that, although exceptions occur,

“On the whole, the earlier the disease begins the quicker is its course. Thus, among those who lived not more than 18 months, I find that the average age at which the disease was first observed was 43 years. Among those who lived between 18 and 36 months, it was 51 years; and among those who lived between 3 and 8 years, the average at the commencement of the disease was 56.7 years.”

These statistics are taken from cases which had not been interfered with by operation.

From six months to fifteen or twenty years may be considered to be the duration of cases of cancer of the breast, but a very large proportion die at some period between six months and three years.

Involvement of Lymphatic Glands.—As has already been mentioned, the time of such involvement varies; one, two, or many glands may become affected in the axilla, and for some time such glands may be movable and circumscribed; but as the case progresses, more glands become affected, and the result often is a hard, irregular mass in the axilla, pressing upon the veins and nerves, giving rise to œdema of the whole arm, and to pain more or less aggravated. The infection of the glands would appear to take place not directly through the lymphatic vessels themselves, but by means of cells forming in the lymph-spaces of the breast, and then being carried along the radicles of the lymphatic vessels which are continuous with these spaces. The glands having once become involved, act as centres for the spreading of the cancer, for the infection of the blood through the thoracic ducts, and for the implication of internal organs.

Lymphatic glands in the axilla are occasionally enlarged from inflammatory irritation in connection with cancerous disease of the breast, especially if ulceration or sloughing be present. The cancerous gland is hard and firm; the inflammatory enlargement is not so hard, and is relieved by soothing applications. Less frequently the glands under the clavicle and in the cervical region become affected, and hard cords are sometimes felt passing from the breast to lymphatic glands in both axilla and neck. I have occasionally seen such cords, resembling inflamed lymphatics or veins passing down into the abdominal wall. It may be here noted that the situation of the cancer does not appear to influence glandular affection, and further, that when there is early glandular affection, the disease is more acute and runs its course more rapidly.

Involvement of the Skin, Deeper Textures, and Internal Organs.—The skin may at any time become involved in the disease. At first this may be in the form of an adhesion or infiltration which confines itself to one point, and gradually becomes more marked, or discoloration with thinning of the skin may take place early, and soon be followed by suppuration and ulceration. In one form of the disease, which is not very common, the whole skin and subcutaneous tissue over the breast, become thickened and infiltrated, and this condition may spread and affect the whole skin of the thorax, portions

of the abdominal wall, and occasionally the skin over the shoulders, back, and arms, the so-called cancer "*en cuirasse*." When ulceration takes place, it spreads more or less rapidly, and may be associated with sloughing; so that the tissues may be destroyed by both of these processes. In rare cases the whole diseased mass perishes, the slough or sloughs separate, and the ulcer heals. Associated with ulceration there may be fungation of the growth, but this is much more common in the medullary form of cancer. Occasionally the ulcerated surface of a cancer will heal at one point while the disease is progressing at another. The muscles, fasciæ, and even the neighboring bones, may become involved by infiltration of the cancerous material, and in such cases the breast is usually very adherent to the deeper parts. The disease may so seriously affect the pectoral muscles as to form in them a tumor of considerable size. The pleura and lungs may become involved, either by direct extension of the disease through the lymphatic system, or more rarely through the bloodvessels, or in both of these ways.

The other internal organs, and distant tissues, are most frequently infected through the lymphatic system, but occasionally through the general circulation.

MEDULLARY CANCER.—As has already been mentioned, this form of cancer occurs in the breast in about five per cent. of all cases. It has usually been described as occurring as a rule at an earlier age than scirrhus, but, according to Gross, "it occurs as early as 29 and as late as 69 years, the average being 50. Twenty per cent. of all cases are met with before 40, and eighty per cent. after that age, while exactly one-half occur after 50."

The tendency of this disease is to run its course more quickly than scirrhus, to attain a larger size, to affect the skin earlier, to ulcerate, fungate, and bleed more frequently, and to cause a greater enlargement of the lymphatic glands. According to Gross, local recurrence takes place "within three months after removal, in 81.81 per cent. of all cases. Metastatic growths are always discovered on post-mortem inspection, and are preceded by taint of the glands of the axilla in three-fourths of the instances, and the total duration of life without surgical intervention is only eight months." These growths are usually more or less lobulated; they may be at first firm to the touch, or they may be from the beginning soft and elastic. They become softer as they grow, and often fluctuate at one or more points, owing to the formation of cysts in their substance. They have been known to grow to the size of a child's head in the course of a few weeks or months.

Treatment of Cancer of the Breast.—As no medical or local treatment short of the removal of the entire growth and breast has as yet been discovered for the cure of this disease, the choice of treatment lies between an operation and the employment of some palliative means to relieve the symptoms. The internal administration of various drugs has been tried for the alleviation of cancer: among these are arsenic, iron, and iodine, with their combinations; alkalies, such as ammonia, soda, and potassa; and acids, especially hydrochloric and phosphoric; but although some of these may be useful in improving the condition of the general health, they cannot be said to have any effect upon the disease itself.

Various vegetable infusions have also been lauded in connection with the treatment of cancer, and among these, infusions of the cliver grass (*Galium aparine*) have occasionally been thought to do good. Mr. Cooke¹ advises a fresh infusion made by pouring a pint of boiling water upon two ounces of

¹ On Cancer, its Allies and Counterfeits.

the stem of the plant, half of this to be taken in twenty-four hours; or a tablespoonful of Squire's expressed juice three times a day. The administration of general sedatives by the mouth or rectum, or by subcutaneous injection, is advisable in cases attended by much suffering which cannot otherwise be relieved. The particular form of sedative, and the manner of its use, must depend upon the special conditions and tolerance of the patient. Local applications of a caustic or irritating nature ought never to be applied, unless with the object of thoroughly and at once destroying the whole diseased mass, and even under these circumstances their use should be confined to cases in which the patients object to the knife. Topical remedies, when used, should be of a soothing nature, and among the best of them are warm water, belladonna, and sugar of lead; the two latter may be used as lotions, or in the form of a plaster, according to the nature of the case. It is important, also, to prevent any undue or irritating pressure upon the tumor, by means of proper arrangement of the dress. In cases where ulceration or sloughing is present, and when the case is not suitable for operation, or the patient declines to have an operation, non-irritating applications should still be the rule. When there is much offensive discharge, the application of a charcoal or elm poultice is often useful in cleansing and soothing the sore.

Boracic-acid lotion, boracic ointment, or equal parts of boracic ointment and vaseline, are also good applications; these latter dressings may be covered with layers of salicylic wool, carbolized wool, or antiseptic marine lint. Gross advises as a deodorizer, and also for relieving pain, an ointment consisting of five grains of chloral hydrate to one ounce of cosmoline.

Esmarch uses a powder composed of arsenious acid and muriate of morphia (of each 0.25), calomel 2.0, and powdered gum Arabic 12. Half a teaspoonful of the powder is daily sprinkled on the surface. When bleeding takes place from the ulcerated or sloughing surface, some styptic should be applied if simple cold does not stay the hemorrhage. A piece of lint or cotton-wadding soaked in a solution of alum or tannin, or in the tincture of the muriate of iron, or in a mixture of equal parts of tincture of perchloride of iron and glycerine, should be applied to the bleeding point. In several cases of feeble and old patients suffering from a limited, ulcerating, and offensive cancer of the breast, I have, with the thermo-cautery, freely removed the ulcer and surrounding disease, without attempting to take away the whole breast. Two of these patients were 84 years of age, and in both instances a healthy, granulating sore was the result, and much comfort was given to the patients and their friends. When the arm is swollen and œdematous, it should be supported by means of a comfortable sling, and the application of a cotton-elastic bandage around the whole limb should be tried, and continued if found to be useful. Gentle friction upwards of the whole arm often assists in relieving congestion and promoting the venous circulation.

Operative Treatment.—It has already been said that statistics prove that an operation prolongs life in many instances; and the most recent experience undoubtedly shows that early interference and more complete methods of operating, tend to still further prolong life, and to make this formidable disease less rebellious to treatment. The late Mr. Moore¹ directed attention to the importance of removing not only the breast, but all the surrounding textures and lymphatic glands. Gross is of opinion that even in cases of circumscribed tumors this proceeding should be carried out. Dr. Mitchell Banks, of Liverpool, in an interesting paper on this subject,² after remarking that the axillary glands may often be affected without being felt externally, adds that from his experience, "in every case where the breast is removed,

¹ Med.-Chir. Trans., 1867.

² Brit. Med. Journal, December 9, 1882.

the axilla should be cleared out as a necessary accompaniment." Prof. Küster advocates the removal of the axillary glands in all cases. He has operated on 117 cases in this way, and in only two were the glands entirely free from disease when carefully examined. Prof. Gussenbauer also advises the same proceeding, and in addition thinks that the supra-clavicular glands should be removed.

In serious glandular involvement, portions of the axillary vessels and nerves have occasionally been excised. Langenbeck has done so in three cases, but in one of these the patient died from gangrene. Esmarch considers that it may be advisable to amputate at the shoulder-joint in such cases.

Experience and facts then prove that a thorough removal of the tumor, together with the breast, surrounding tissues, and axillary glands, will much improve the chance of permanent relief in this disease. Prof. Küster's testimony as to the frequency with which the glands of the axilla are involved, is most valuable in deciding the importance of taking them away at the time of the operation.

It must be observed that a more complete operation adds somewhat to the mortality; but with careful antiseptic precautions, such mortality is not likely to be large.

An early and thorough operation, including the removal of the glands in the axilla, is therefore advised in all cases of cancer of the breast in which it is possible to remove the entire seat of disease, and in which the patient's general condition admits of such an operation. If a patient objects to the knife, the operation may be performed with the thermo-cautery; and, if circumscribed, the disease may be destroyed by some strong caustic, such as chloride of zinc, in the form either of a paste or of Maisonneuve's arrows. I prefer the method employed by the late Mr. Syme, which consists in applying a paste of strong sulphuric acid and lampblack, the surrounding parts being protected by a wall of gutta-percha, attached to the skin by means of a solution of gutta-percha in chloroform.

Operations in recurring Cancer.—The principle to be followed in these cases is that now usually acknowledged among surgeons, namely, to remove the growth and surrounding parts as soon as the disease recurs, and to repeat the operation as often as may be necessary, provided that the disease remains local and can be removed, and that the patient's health admits of it. I have repeatedly operated on this principle, two, three, four, or more times, and have, in this way, prolonged patients' lives; and most practical surgeons have had like experience.

Method of Operating.—No strict rule as to special incisions can be laid down in connection with removal of the breast for cancer. The nipple and skin around it should always be taken away, and when the skin is at any point adherent to the breast or tumor, or is affected with the disease, it should be freely removed. The incisions should be made in such a direction and to such an extent as thoroughly to expose the whole breast and the tissues around it, to take away the nipple and areola, with any adherent or affected skin, and to expose the axillary space. Another point, but it must be considered a minor one, is to make the incisions so that the edges of the wound may be approximated without tension, and with least risk of their separation by muscular action. When the whole breast and the surrounding textures have been thoroughly exposed (and in dissecting off the skin and areolar tissue care must be taken not to separate along with them portions of breast-structure), the mass should be removed, together with the fascia on which it rests, and then all tissues—fatty, fibrous, or muscular—which show any signs of involvement should be taken away, and the axilla carefully searched and all glands removed. If there is any difficulty in getting access to the axil-

lary glands, one or both pectoral muscles may be divided; but this proceeding is not often required.

In removing glands from the axilla, it is important to ligature any vessels that are met with before dividing them, as there may be difficulty afterwards in securing them, more especially if they are divided close to the main trunks. In cases where the edges of the wound cannot be brought together, I have sometimes found it useful to stitch the skin of the flaps to the muscles below, so as to prevent its inversion and retraction. It need scarcely be said that the whole operation should be conducted on strictly antiseptic principles.

AFFECTIONS OF THE MALE BREAST.

HYPERTROPHY.—The male breast has occasionally been met with largely hypertrophied, and if such a condition should be troublesome, removal of the gland would be the best proceeding, if the patient's health admitted of an operation.

INFLAMMATORY AFFECTIONS.—The male breast may be affected with inflammation, and occasionally an abscess results. An enlarged and tender condition of one or both glands occurs sometimes in young men. The elder Gross refers to three cases in his work on Surgery, and I have met with two cases affecting the left breast. In one of these the condition returned several times, leaving the breast somewhat enlarged.

The *treatment* of these conditions must be soothing, locally, with avoidance of any injurious pressure from the clothes, and the administration of saline aperients, followed by tonic remedies if the health is not good.

TUMORS.—Both simple and malignant growths are occasionally met with in the male breast. Among the former are cysts (in one recorded instance the cyst contained milk) and fibromas. Among the latter are spindle-celled sarcomas, of which I have seen two examples, and cancers, which are most frequently of the scirrhus variety. The simple, infiltrated, atrophic, and cuirass-like form have all been observed in the male breast. About two per cent. of all cases of mammary cancer occur in the male breast, and the disease runs its progress more or less rapidly, and involves other tissues and organs, as in women.

The *treatment* of the various tumors which affect the male breast is that of similar tumors as they occur in the female.

INJURIES AND DISEASES OF THE ABDOMEN.

BY

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CONTUSIONS OF THE ABDOMINAL PARIETES.

CONTUSIONS of the abdominal parietes may or may not be associated with injury to some of the abdominal contents. If the viscera be involved, the seriousness of the injury depends upon the damage within the abdomen; if not involved, the severity of the case varies with the area and depth to which the parietes are contused, and more especially with the depth. Thus, contusion of the skin and muscles is more serious than contusion of the skin alone, and if the peritoneum partakes in the injury, the gravity is greatly increased. Where a severe abrasion or an actual wound exists, or a large bloodvessel or muscle has been subcutaneously ruptured, or the tissues disorganized by pulping, the risks of the contusion are increased by the complication. Contusions of the parietes may be grouped into (1) Simple contusion or bruise; (2) Contusion with extravasation of blood; (3) Contusion with ruptured muscle; (4) Contusion with pulping or actual disorganization of tissue; and (5) Contusion followed by inflammation and suppuration.

SIMPLE CONTUSION OR BRUISE.—The *symptoms* are ecchymosis, tenderness, pain, swelling, and shock. *Ecchymosis* does not invariably follow a severe blow, and, on the other hand, a slight blow may give rise to wide-spread and extensive discoloration of the skin. Ecchymosis, by which is meant rupture of the capillary vessels of the skin and subcutaneous tissue, and the external discoloration which results therefrom, must not be mistaken for extravasation of blood amongst the deeper structures. Thus, there may be considerable hemorrhage amongst the muscles, or in the subperitoneal tissue, and yet no ecchymosis. When the extravasation occurs from the capillaries of the subcutaneous tissue rather than of the skin, ecchymosis may be delayed until after an interval of three or four days. The ecchymosis may extend uniformly over a considerable surface, or may occur as a number of petechiæ thickly placed, as was well seen in a boy under my care, whose chest and abdomen had been squeezed against a wall by the backing of a wagon; his face, in the course of twenty-four hours, became thickly covered with minute ecchymoses, until it presented a dusky-red color throughout; his abdomen, chest, and other parts were similarly but to a less degree affected. In the course of several days he regained his proper appearance and recovered. Persons with much subcutaneous fat, or with a purpuric state of blood, and those with a strong tendency to hemorrhage from trivial causes, and characteristically styled “bleeders,” show most discoloration after simple contusion. The degree of ecchymosis depends, too, upon the region of the abdomen contused; thus, in the umbilical and epigastric regions it occurs more readily than in the lumbar.

Tenderness over the seat of injury is probably the most constant symptom, and it may exist without any other sign. It may be very slight, or very extreme in degree. When experienced immediately or very shortly after the injury, it does not indicate internal mischief; but when coming on only after many hours, or a day or two, it points to the onset of peritonitis.

Swelling depends on the amount of blood, or bloody serum, which is effused, and upon the texture of the region contused. In the loose tissue of the loin it is sometimes very considerable. There is nearly always some slight degree of tumefaction after a blow, even too gentle to rupture the cutaneous capillaries; in these cases there is no ecchymosis, but the part struck is tender and painful, becomes slightly tumefied, then turns red, and in twelve or twenty hours presents no trace of having been hurt.

Pain either is caused by the contusion or actual laceration of the nerves, or is due to pressure of the effused fluid upon them. It is not often severe in uncomplicated contusions, as long as rest is observed, and the abdominal walls are not disturbed by coughing or vomiting; such, or indeed any movements, aggravate the pain.

Shock, in simple contusions, is an uncertain symptom both as to frequency and degree. Sometimes there is none at all; for the suspension of the functions of the part injured, as evinced by the benumbing of the surface, and the temporary suspension of muscular action, are merely the direct local effects of the blow. In other instances the shock is sufficient to kill outright. Pollock and Bryant consider the evidence of the truth of the old doctrine—of sudden death caused by a blow on the abdomen, without visible intra-abdominal lesion—to be unsatisfactory. Le Gros Clark, without denying its occurrence, says that he has never seen a case; and Holmes remarks that, if the doctrine be true, the event is unquestionably rare. Sir A. Cooper, however, quotes the case of a man who was struck on the epigastrium and fell dead on the spot; and Dr. Hunter McGuire, in the second volume of this *Encyclopædia*, states that he saw a man, struck on the buckle of his sword-belt by a minié ball, fall dead in a few minutes, a contusion of the abdominal parietes being the only post-mortem evidence of injury. This case seems to carry conviction with it of the truth of the old doctrine.

Vomiting is an occasional and early symptom, especially if the injury happen shortly after taking food.

It should be borne in mind that a contusion of the abdominal parietes may be followed by no immediate symptom, and yet that, after seven or eight days, uncomplicated traumatic peritonitis may set in; just as a blow or fall on the head may cause no appreciable symptom at the time, though coma or delirium may supervene after a week or two.

The *causes* of contusion are either direct blows, kicks, falls, violent pinching force, the rough pressure of a nurse's hand, or the forcible compression between two opposing bodies, as in many railway accidents.

Diagnosis and Prognosis.—It is sometimes impossible to say, for a time, whether an injury is simply a contusion of the abdominal parietes, or whether the abdominal contents are injured as well. Neither the degree of shock, nor the kind and amount of pain, nor the presence or absence of tenderness or ecchymosis, enables us to form an immediate diagnosis. Time, and close attention to the development of symptoms—to the character of the vomit, if any; inspection of what passes per rectum; and an examination of the urine—will alone suffice. If, however, extreme collapse, with pallor, rapidly or steadily increasing, follow directly after the injury, it will almost certainly point to laceration of, attended with hemorrhage amongst or beneath, the muscles; or to rupture of one of the abdominal organs. Results alone determine what injuries are superficial and what are associated with grave internal lesions,

and every abdominal injury should be treated as if it were serious, until its true nature has been developed by time. Hospital records are suggestive of the probabilities of diagnosis and prognosis, and give an idea of the average risks in contusions of the abdomen. Speaking roughly, it is found that about three-fifths of the patients recover without more than slight and passing symptoms; in considerably less than one-fifth of the cases, symptoms of peritonitis will set in; and in considerably more than one-fifth, rupture of the viscera complicates the contusion, or occurs without any apparent injury of the parietes.

Treatment.—There is no injury of the abdomen, as there is none of the head, which ought not to receive immediate and careful attention. Early precautions may prevent future serious consequences; and even if time shows the results to be slight, the rest and quiet will have conduced to the avoidance of mishap. In all cases, then, after contusion—whether the symptoms be grave or slight—rest in bed, and muscular relaxation, by elevating the head and shoulders and flexing the thighs on the abdomen, must be insisted on for a few days; and if pain be felt, warm fomentations should be applied to the belly. Collapse must be met by warmth to the extremities and to the spine; and, if requisite, by the administration of ammonia or other stimulant. If a blood-tumor exist, it may be tapped with the aspirator; or cold, and pressure by means of strips of adhesive plaster, may suffice to reduce it. If peritonitis supervene, opium should be given, to an adult, in doses of a grain every four or six hours; warm fomentations should be constantly applied; and twenty or thirty leeches should draw blood from the surface of the affected part. In young subjects, the same remedies, but in milder measure, are required.

CONTUSIONS COMPLICATED BY EXTRAVASATION OF BLOOD may involve the rupture of either of two important sets of vessels: the superficial and the deep. Rupture of the *superficial vessels*, more especially of the superficial epigastric, may give rise to such considerable extravasation that the skin of the iliac, hypogastric, and umbilical regions, may be of a black color. The blood may pass downwards to the scrotum and thighs, or, owing to rupture of the deep fascia, the extravasation may go on beneath it, and the discoloration will then extend beyond Poupart's ligament, to which the deep fascia is attached. After rupture of the *deep vessels*, the extravasation will occur beneath the muscles, and between them and the peritoneum, or it may be into the sheath of the rectus. When into the sheath of the rectus, the swelling will be quite circumscribed. When beneath the muscles in the iliac and hypogastric regions, the effusion is in the cellular tissue over the external surface of the peritoneum, above, on each side of, and below, the pubis. Hennen¹ records a fatal case of this sort in a man aged 60 years, who was run over by a carriage. The enforcement of absolute rest, with the constant application of cold, or of evaporating lotions, is the proper treatment in these cases; rarely will the aspirator be necessary, but if the effusion be great and the absorbent powers small, it should be used. Should there be signs of continuing hemorrhage, and if the source of the bleeding is known or can be shrewdly guessed at, an exploratory incision may allow of the ruptured vessel being ligatured above and below the rent. It must be acknowledged, however, that cases of the kind are very rare, and, for the most part, have been recognized only on post-mortem examination. There are no symptoms upon which absolute reliance can be placed; even fainting to syncope cannot do more than lead us to suspect the persistence of bleeding, and this symptom is frequently an attendant upon intra-abdominal injuries in which an exploratory incision would be of no avail.

¹ Principles of Military Surgery, p. 102.

RUPTURE OF SOME OF THE ABDOMINAL MUSCLES may complicate contusion. The rectus is more prone to rupture than the flat muscles of the abdominal walls. This accident may occur from direct or indirect violence: a violent and abrupt blow upon a healthy muscle in a state of extreme tension, or a slight blow upon a muscle enfeebled by typhoid or other fever, or any debilitating illness, may cause it; so, also, may some violent, voluntary muscular effort, made to escape the force of some contusing body. As soon as the fibres are ruptured they retract, leaving a gap or interspace which is soon filled up with blood. After a varying period this blood becomes absorbed, and the gap becomes again apparent. If adhesive inflammation does not repair the breach, the parietes are here permanently weakened, and a ventral hernia will in all probability result. Guthrie was of opinion that a severe blow on the abdomen might lead to absorption of the muscle at the spot injured, and this in turn conduce to hernia, without any actual rupture of the muscular fibres; and he has given cases which he believed to support this view. It is possible, however, that in these and other cases actual rupture did really occur, but was not detected owing to the rapid effusion of blood into the rent in the muscle. I might refer in detail to cases of ruptured rectus associated (1) with contusion of the parietes alone, and (2) with contusion of the parietes and rupture of abdominal viscera, but this is unnecessary for the sake of illustration. Ruptures of abdominal muscles, especially of the rectus, during slight or moderate muscular effort in fevers, and in the violent contractions of delirium, have also been observed. Other cases of ruptured abdominal muscle occur from contusion without any lesion of the integuments, but with laceration, detachment, or contusion of the peritoneum. The treatment in all such cases is the same: namely, to relax the muscles so as to approximate the separated edges, and to maintain them in contact, if possible, during repair. Should a ventral hernia occur, a well-adjusted, flat or slightly concave truss, well padded, and retained by means of a suitable belt and buckle, with brace-straps if necessary, should be worn.

CONTUSION WITH PULPEFACTION OF INJURED PARTS. - Contusion may be so excessive that entire pulping or disorganization of the contused parts may occur, and gangrene be the absolute result. In this complication repair can only take place after the destroyed tissues have been cast off by the process of sloughing. If the injury be superficial, and if the process involve only the skin, a superficial, cellular-tissue cicatrization will soon commence; but if the disorganized tissues be deep, and the skin but little or not at all affected, inflammation and suppuration occur, loosening the gangrenous parts and also attacking the overlying structures, until abscesses are opened and sloughs removed through the incisions made. The abdominal walls are left weak; and hernial protrusions follow the tardy completion of the healing process. The treatment of this complication is the same as that required for the separation of gangrenous tissues in other parts of the body: the strength of the patient must be kept up, opium must be given to allay pain and irritability, the appetite must be improved by the use of quinine or ammonia and bark, and warm fomentations and antiseptic applications must be liberally supplied to the parts involved.

INFLAMMATION by no means seldom follows contusions of the abdomen, and it may be either superficial or deep, according to the position of the contused tissues; or it may extend from one stratum to another of the abdominal walls. It is attended with all the common phenomena of inflammation in similar tissues in other parts of the body.

SUPPURATION AND ABSCESS OF ABDOMINAL PARIETES.—*Causes*—Either diffused suppuration or abscess may result from a blow or fall, or from forcible pressure upon the abdomen or loin, and they are among the complications or consequences of contusion. Or they may arise from strains of the abdominal muscles. Extravasation of blood, however produced, may give rise to suppuration, owing to the non-absorption or breaking down of the coagula. Extravasation of urine leads to diffuse suppuration and sloughing, always serious, and sometimes fatal; I have seen it spread in the course of a day or two over the whole of the lower two-thirds of the abdomen, and reach far back into each loin. The bursting of an empyema, or of an hepatic abscess, may lead to long and tortuous suppurating tracks in the abdominal walls. Disease of the vertebrae, of the lower end of the sternum, of the ribs and costal cartilages, or of the bones of the pelvis, is frequently the cause of suppuration in the abdominal parietes. In any part of the walls, but especially in the groins and loins, suppuration may extend from the viscera within the cavity of the abdomen or pelvis: thus an abscess which had its starting point in the pelvis, between the uterus and bladder, spread along beneath the peritoneum, across the psoas muscle, until it reached and was detected in the loin.

But abscesses in the abdominal wall may not be traceable to any definite cause; and they are prone to arise from very trivial causes, here as elsewhere, in scrofulous, anæmic, feeble, syphilitic, or otherwise cachectic subjects. They are prone to occur after fever.¹ They are of course met with in pyæmia and in cellular and cellulo-cutaneous erysipelas, both in the circumscribed and diffused forms. Diffused abscesses are generally deep-seated, and occur amid the loose cellular tissue under the tendinous and muscular expansions; here fluctuation and pointing are not often met with, as the tissues intervening between the abscess and the integument resist the pressure of the pus, and are but little, or not at all, susceptible to ulceration. Superficial, diffuse suppuration is only to be met with as a consequence of erysipelas, or where there is great want of power, and therefore but little or no tendency to the adhesive form of inflammation.

Circumscribed abscesses of the abdominal parietes may occur (1) superficial to the muscles, (2) on the deep surface of the muscles, (3) between the muscles, and (4) within the sheaths of the muscles. In the *front* of the abdomen they are rare between the muscles, their usual situation being either subcutaneous, or within the sheath of the rectus, or between the transversalis and peritoneum. Occasionally they arise in the loose cellular tissue about the xiphoid cartilage.

In the *lateral and posterior regions* intermuscular abscesses are less rare, and subcutaneous collections of pus are by no means uncommon in the loins. When an abscess forms on the superficial aspect of the middle layer of the transversalis aponeurosis, whether it be within the sheath of the serratus posterior, of the latissimus dorsi, or of the erector spinæ, the tendency is for the matter to come towards the surface, and then, unless evacuated, to descend subcutaneously to the back of the sacrum, or on to the gluteal or femoral regions. On the other hand, if the abscess forms on the deep aspect of the middle layer of the transversalis aponeurosis, as for example within the sheath of the quadratus lumborum, its tendency is towards the cavity of the abdomen, which it will penetrate unless opened in good time by the surgeon.

An abscess which has commenced in the areolar tissue about the *cæcum*, may open on the front of the abdomen in the right iliac region; one which has commenced near the *sigmoid flexure* may open in the left iliac region; and one which has begun in the cellular tissue around the *kidney* or *colon*

¹ A case of abscess in the rectus abdominis muscle after enteric fever, is registered in the Transactions of the Pathological Society of London, vol. xvi. p. 275.

may burst into the bowel, the lung, the pelvis of the kidney, or the peritoneum, if it be not opened through the loin.

Owing to the firm connection of the subcutaneous areolar tissue to the spinous processes of the vertebræ, it is seldom that pus burrows across from one side to the other of the median line in the back. Abscesses in the epigastric region have a tendency to spread, but rarely penetrate the peritoneum, on account of the strong tendinous aponeurosis which prevents them from doing so. In the umbilical region, if in front of the rectus but within its sheath, the intersections of the muscle and their connections with the sheath prevent pus from spreading upwards or downwards; but when behind the rectus, though within the sheath, it can spread upwards or downwards to a great extent; when outside the sheath and on its deep aspect, it can diffuse itself in all directions; and if beneath the fascia transversalis, it may burst into the peritoneum. In the hypogastrium, subcutaneous abscesses remain for a long time circumscribed, but after a time become diffused if left unopened. Deep abscesses in this situation are dangerous in their consequences, and slow in their course, as a rule. In the iliac regions, besides those already alluded to, abscesses the result of pelvic cellulitis are prone to open. The superficial abscesses in these situations simulate buboes, and are often wrongfully attributed to venereal causes.

Symptoms.—Though the symptoms are, as a rule, acute, and such as characterize acute abscess in other parts, they are sometimes insidious in their onset, slow in their progress, and but little marked even for several weeks. In the *acute* form the onset is sudden, with vomiting, severe local pain, rigors preceding febrile action, full pulse, flushed countenance, thickly-coated tongue, severe headache, and perhaps the general symptoms of fever.¹ For a few days these symptoms may be accompanied by delirium, and the local pain increases, without, however, any *general* abdominal hardness or tenderness; at length the seat of the abscess becomes more evident by redness and œdema of the skin, brawny hardness, and acute tenderness, and within a few days more an obscure softness, but no distinct fluctuation, will be detected. A free incision will now let out several ounces of laudable pus, and from this time all the symptoms will subside, and the patient rapidly recover. If the abscess be deeply seated, the pain may be very widely diffused over the abdomen, and the case for a time is likely to be mistaken for one of acute peritonitis; and it must never be forgotten that these abscesses are liable to set up peritonitis, and even to burst into the peritoneal cavity. When due to an injury, such as a strain or blow, the symptoms may set in at once, or not until several days or even a fortnight afterwards, when violent pain in the part, accompanied by all the severe, constitutional symptoms of acute abscess, appear suddenly. These features were well exemplified in the case of a healthy girl, aged fifteen, who fell from a ladder, striking the right side of the abdomen; this caused her pain for a day or two, but she thought no more of it until a fortnight later, when she became acutely ill; peritonitis after a while supervened, and death from hectic occurred at the end of seven weeks from the date of the injury. A post-mortem examination revealed a large abscess on the right side of the abdomen, between the external and internal oblique muscles, about three inches in diameter; pus had diffused itself through two holes in the internal oblique and transversalis muscles, outside the peritoneum, under the right false ribs; here it had penetrated the peritoneum, and had formed two ulcerated holes in the liver; circumscribed pus was also found on the lesser omentum.²

In the *chronic* form, if the effused inflammatory products are deeply seated

¹ See *Lancet*, vol. xi. p. 367; case under care of Sir William Lawrence.

² *Edinburgh Medical and Surgical Journal*, vol. ii. p. 129.

and firmly bound down, they may give the sensation of a hard, rounded tumor. The pain in these cases often takes the course of some one of the abdominal nerves, and may be quite superficial, and of a constant, fixed, aching character, rather than severe. The patient will probably continue to go about his business, the febrile and constitutional disturbance will be slight, the cutaneous and subcutaneous tissues will be unaffected, and the introduction of a grooved or aspiratory needle, even three or four weeks after the detection of the "lump," may not be followed by the escape of anything but a drop or two of blood. By degrees, however, the pain becomes more severe as the softening of the inflammatory products progresses, and an obscure sense of deep fluctuation may be felt; an exploratory incision will now reveal the existence of pus, perhaps of a very fetid odor from proximity to the bowel. Immediate relief will follow the evacuation of the pus, and convalescence, as a rule, becomes quite established; but in some cases an exhaustive discharge continues, the appetite fails, the strength completely gives way, bed-sores form, hectic supervenes, and the patient dies at some period from a few weeks to a few months from the onset.

Deep-seated abscesses, whether idiopathic or the result of contusion or wound of the abdominal walls, are liable to be followed in the course of time by hernial protrusion at the seat affected. The accompanying wood-cut (Fig. 1201) shows a hernial tumor following an ilio-psoas abscess, which had burrowed up and opened at the inguinal region. Nearly the whole of the hollow viscera were contained in the hernia, and reduction of any part of it some years after its first formation was quite impossible. In another case, that of a retired soldier, a large, flat, tympanitic, doughy swelling in the epigastric and right hypochondriac regions followed an abscess, the result of a wound of the abdominal wall. In this case the hernia, though large, was not pendulous, and could be retained within the abdomen by a well-fitting belt.

Diagnosis.—It is often difficult, indeed impossible, to diagnose abscess of the abdominal parietes in its early stage. This arises in part from the fact that, in every region of the abdomen, inflammation and suppuration of the walls are apt to simulate the same affections of the subjacent viscera. It is therefore necessary to bear in mind the normal position of the abdominal viscera, and to have a knowledge of the various sorts of swellings which

Fig. 1201.



Irreducible, ilio-inguinal hernia, following ilio-psoas abscess in a woman. Bands of firm, fibrous adhesions could be clearly seen and plainly felt through the very thin and overstretched integuments.

occur in the several regions. Thus, in the hypochondria, parietal abscess may simulate hydatid or abscess of the liver, enlarged gall-bladder, diseased spleen, a circumscribed collection of pus beneath the diaphragm, or empyema. A further difficulty exists if the parietal abscess is combined with jaundice. In the umbilical region, strumous disease of the mesentery, malignant affections of the stomach, pancreas, and peritoneum, and fecal accumulations in the transverse colon; in the loins, affections of the kidney, colon, and spine; in the iliac regions, disease of the cæcum or sigmoid flexure, of the kidney, or of the pelvic organs, and enlarged lymphatic glands; and in the hypogastrium, pelvic cellulitis, and ovarian and uterine disease, have been known to simulate or be simulated by parietal abscess. Difficulty of diagnosis may arise, too, from an abscess forming whilst a patient is undergoing treatment for some other ailment. I was once greatly concerned about a brawny, tender swelling, accompanied with much constitutional irritation, which formed in the hypogastric region of a very stout young Dutchman, upon whom several days before I had used Holt's dilator for urethral stricture. There was no trouble about the bladder or urethra, and no sign whatever of extravasation, but the inflammatory condition of the abdominal parietes was enough for a time to cause some alarm. After several days an abscess pointed and was evacuated, and the patient made a rapid recovery; the suppuration was entirely superficial to the muscles, and in the loose, thick, subcutaneous fatty tissue.

Fibrous, fibro-cellular, and malignant tumors have been mistaken for chronic or subacute abscesses; and "phantom tumors" may also lead to error. These "tumors" are due to tonic contractions of portions of muscles, and may occur in almost any part of the abdominal walls. Most frequently they are found in the course of the rectus, but sometimes in the transversalis, one of the oblique muscles, or the quadratus lumborum. They are more or less circumscribed and hard, and can be recognized by their being fairly resonant, not painful or tender on pressure, and by generally disappearing under continued manipulation, and during the withdrawal of the patient's attention.

It will be only after a careful investigation of the symptoms and clinical history, and repeated examination of the indurated or tender area of the abdominal walls, that a correct opinion can be arrived at in a large number of cases. Assistance in some instances will be gained by a rectal or vaginal exploration, and the excretions from the bowels and kidneys should always be examined. Sometimes an exploratory incision or puncture will be required to make the diagnosis quite clear. When the abscess, or inflammatory deposit which precedes abscess, is chronic, it constitutes one of the many causes of the "fixed abdominal pain," and then has to be distinguished specially from inflammatory adhesions within the abdomen, and from the dragging of displaced omentum, colon, or sigmoid flexure.

Treatment.—This is the same as for local inflammation and abscess in other parts of the body. Rest, the use of warmth and fomentations, the application of from 12 to 20 leeches, and the administration of cooling salines, will subdue the intensity of inflammatory action; and anodynes will be required to allay pain. As soon as the presence of matter is suspected, an exploratory puncture should be made, and the sooner the abscess is freely evacuated the better.

There is danger in leaving deep abscesses unopened, as they are liable to set up peritonitis and terminate in fecal fistula; nerves, too, may be dissected out and lie bare in the cavity, and bloodvessels may be ulcerated into. The iliac veins have been thus laid open by abscesses spreading from the loins; the kidney has become disorganized, and the vena cava obliterated, by the pressure of an unrelieved abscess commencing within the sheath of the quadratus, or in the peri-renal fatty and areolar tissue.

After opening the abscess, nutritious diet, and stimulants and tonics, are needed to keep up or improve the patient's strength. As the organs nearest the affected parietes are apt to become involved, such complications as jaundice, pneumonia, flatulent distension of the bowels, or constipation with pain, from delay in the passage of the intestinal contents, must be treated as they arise. Sympathetic vomiting is often a very troublesome symptom in the onset of the local inflammation, no matter in what part of the abdominal parietes it occurs; a subcutaneous injection of morphia sometimes acts like a charm in checking this, besides having the additional effect of alleviating pain.

BURNS AND SCALDS OF THE ABDOMINAL PARIETES.

Burns and scalds of the abdominal parietes are of a highly dangerous character, but in civil life are seldom limited to this part of the body, being, as a rule, associated with burns or scalds of the thorax, back, or nates and thighs. In military life they are the result of explosions, or the bursting of fire-arms, cartridge-boxes, shells, etc., and are, therefore, frequently accompanied by lacerated and contused wounds of more consequence than the burns. On board ship, very terrible cases, from time to time, occur from the bursting of engine, boilers, etc. The usual classification of burns and scalds applies to those which affect the abdominal walls, and need not be further referred to here. Velpeau has compared burns with contusions from balls and shot; and considers it impossible to distinguish them from one another, or to say how the eschar has been caused; there is in each case sphacelus of the injured parts and reddening of the skin around, whilst the processes of separation of the slough and repair of the wound are the same in both. The constitutional symptoms, prognosis, post-mortem appearances, and treatment, do not differ from those of burns and scalds of other parts of the body. There is no greater tendency to effusion into the serous cavities of the brain, chest, or abdomen; nor to mucro-enteritis, or ulceration of the duodenum or other parts of the intestines, than in burns of corresponding degrees in other regions; though if the destruction of tissues is deep and extensive, there is danger of peritonitis from extension during the inflammatory stage. I have, during this stage of burns involving the abdominal wall, several times found great and widespread pain of the abdomen complained of; and when this has been accompanied with vomiting or diarrhoea, as is sometimes the case, the prognosis has for a few days seemed doubtful, because of the uncertainty as to how far the mucous coat of the stomach or bowel has become involved. The cause of death, when ulceration occurs, is, generally, either hemorrhage from the bowel, or peritonitis from perforation. Holmes¹ gives an illustration of a case in which the pancreaticoduodenal artery was laid open by an ulcer of this kind. Ulceration of the intestine after burns is not, however, necessarily fatal.

That extensive burns in every part of the body may be followed by ulcer of the duodenum, there is no doubt. Holmes states that in 16 cases out of 125, of intense burn, ulceration of the duodenum occurred, and ulcers in other parts of the intestines in two cases. Stokes found ulcers of the duodenum and stomach in one case of severe burn. Mayer says that ulceration occurs from 7 to 14 days after the injury, and is twice as frequent in females as in males. Holmes puts the earliest date at four days, and says that usually it is after a fortnight. Choostels states that, in eight cases, the shortest time within which ulceration of the bowel was noticed was 2 days, and the longest 17 days

¹ Principles and Practice of Surgery, 3d ed., p. 107.

after the burn.¹ It should be mentioned that many other conditions are known to have been accompanied by ulcers of the stomach or duodenum, or both; such as erysipelas, pemphigus, and pellagra. Foreign bodies in the gastro-intestinal tube may of course give rise to ulceration.²

CUTANEOUS ERUPTIONS, CARBUNCLE, FURUNCLE, AND ULCERATION OF THE ABDOMINAL PARIETES.

CUTANEOUS ERUPTIONS.—*Rupia*, *ecthyma*, and most of the cutaneous eruptions, syphilitic and simple, affect the surface of the abdomen, but need not here be considered. The first evidence of secondary *syphilis* is in a large number of cases to be detected in the cutaneous rash on the abdomen; in my experience it is earliest and best seen on the front and sides of the belly.

Herpes zoster not unfrequently affects the abdomen, and may be preceded for some days by severe pain, the cause of which will seem quite inexplicable. If the eruption is coming out low down, upon the surface supplied by the ilio-hypogastric and ilio-inguinal nerves, the testicle may be the seat of pain, and through the irritation of the genito-crural nerve may be drawn up towards the external ring, and a renal calculus may be suspected. The absence of functional disturbance of the abdominal viscera, and the appearance of a crop of vesicles along the course of the nerves, will, however, soon make clear the nature of the case.

BOILS AND CARBUNCLES occur on all parts of the abdomen and in the lumbar regions, and are by no means uncommon, though less frequent here than on the neck and on the nates. I have had to treat some very severe cases of carbuncle both in the hypogastric and lumbar regions, and have had the happiest results, here as in other parts of the body, by wiping over the surface and edges with liquid carbolic acid, lightly applied by means of a small wad of cotton-wool, and boring three or four holes into the swelling with crystals of the acid pressed upon the surface; as soon as the acid has penetrated the skin, it permeates the diseased structures and its action becomes widely diffused. Sometimes, three or four days are required before a free opening is effected; but I have always found the spreading of the carbuncle to be checked by the first application, and am so impressed with its beneficial effects that I take this opportunity of recommending it to those who have not tried it.

ULCERATION of the surface of the abdomen occurs as the result of neglected, irritated, or badly treated scratches or abrasions of the skin, and of the excoriations about the umbilicus and in the groins of persons of dirty habits and unhealthy constitution. The umbilicus in new-born babes, and in very fat adults, occasionally becomes inflamed and ulcerated from neglect of cleanliness. In the former, after the separation of the stump of the funis, profuse suppuration, or serious ulceration, attended sometimes by fatal hemorrhage, occurs instead of healthy cicatrization: I have seen ulceration from this cause followed by fatal erysipelas of the parts around the umbilicus.

Treatment.—If the ulceration is slight, cleanliness, and the application of lead lotion or benzoated-zinc ointment, will suffice; if it becomes indolent, some stimulating lotion or ointment will be required. If there is much inflammation, or hemorrhage, prompt and decisive treatment to check the

¹ Am. Journal Med. Sciences, October, 1883.

² See section on Foreign Bodies in Stomach and Intestines.

one or the other must be adopted, since the inflammation is prone to spread, and the bleeding to recur, and since either condition may end in death in the course of a few days.

I have also known ulceration to arise from a simple *pimple*. This occurred in the person of a stoutly built and apparently healthy woman aged 48, who for some time had had a small, hard pimple situated about two inches above Poupart's ligament; it at length became red and irritable, and in the course of six days enlarged to the size of a walnut; within another four or five days it was a large, ovoid ulcer, 12 inches by 7, with thickened edges, and a profuse, offensive, purulent discharge from its base. During cicatrization a great deal of superficial pain was felt, extending from the back to the groin, which was relieved by the application of belladonna ointment to the edges of the ulcer. The healing was very slow, and took nearly four months for its completion, the patient nearly the whole time, after being first seen, keeping her couch. The origin of the ulcer appeared to be quite local, and due to the chafing and neglect of a simple pustule; there was no syphilitic taint, and there were no enlarged glands, nor sores in other parts of the body. Iodide of potassium and mercury had no effect upon the ulcer, which however healed under the application of vaseline, and then carbolic-oil dressing (1 in 40), and the internal administration of quinine and iron.

It is possible that an ulcer such as the above may have a *venereal origin* without being of a syphilitic nature. If an inflamed follicle or an abraded pimple, in the hypogastric or iliac region, or elsewhere, is inoculated by the discharge derived from an impure connection, it is very likely to assume a spreading, chaneroidal character. I have witnessed an ulcer of this kind, above the pubes of a man, gradually eat its way into a circular sore the size of the palm of the hand, with raised edges and an irregular, ashy-gray base. It was cured in the course of a few weeks by the local application of black-wash, the use of opium in small and frequently repeated doses, and complete rest in bed.

A soft chancre or an open bubo may take on a phagedenic action, and spread widely over the lower part of the abdomen, as well as over the buttocks, along the thighs and up the vagina, being accompanied by fierce and terrible pain. Owing to the looseness of the tissues about the groin and lower parts of the abdomen, they easily become infiltrated with the acrid fluids from the sore, and sloughing goes on in them very rapidly unless checked by active treatment. These ulcers, though of venereal origin, never occur as the result of syphilis. As a rule, they affect young, weakly, debauched and half-starved men and women—more especially women. Happily they are now rarely met with, at any rate in London hospitals; but I have seen one or two horrible examples of this kind of ulcer, where the muscles of the abdominal walls, and of the gluteal region and inner side of the thigh, had been cleanly dissected out by the phagedenic process, and, together with the hectic and emaciated face and wasted limbs of the terror-stricken and suffering patient, formed a sickening sight never to be forgotten.

The *treatment* of this kind of ulcer consists, in the early stage, in the application of strong nitric acid or the acid nitrate of mercury, once or twice repeated if necessary; this has in some cases converted the phagedenic sore into a healthy one, and at the same time has given quick relief from pain. If the case is not seen early, opium and tonics internally, with a good, nutritious diet, a moderate allowance of stimulants, the local application of opium, with boracic or carbolic acid lotion, and scrupulous cleanliness, must be trusted to. The prognosis is however gloomy.

ERYSIPELAS OF ABDOMEN.

Cutaneous erysipelas of the abdomen is sometimes seen as part of an attack of general erysipelas of the trunk, and spreading sometimes to the upper parts of the thighs and arms. It occurs occasionally after excision of the mamma, and the removal of tumors from the abdominal walls, and slowly spreads until it has involved the thorax, abdomen, back, and buttocks. It is generally seen in fat persons past middle age, whose kidneys are advanced in granular degeneration. It will arise in spite of the most rigid antiseptic precautions and dressings; it is not in my experience contagious, but is very dangerous to the life of the patient. It bespeaks a low degree of vitality, and though the individual may before the operation have appeared robust, the urine is generally found to be of low specific gravity, and the recuperative power exceedingly small. In five fatal cases out of seventy-three of breast-amputation which I have performed, three of the patients died from this form of erysipelas.

AFFECTIONS OF THE UMBILICUS.

EPITHELIOMA OF THE UMBILICUS is a rare disease. M. Després recently reported a case at the Société de Chirurgie, of a woman aged sixty-five upon whom he had operated, removing the tumor by two semicircular incisions. He had to remove at the same time parts of the peritoneum and omentum which were invaded by the epithelioma. The tumor removed, he plugged the wound with the omentum, and thus left an epiplocele in place of the cancer. The patient was well in a fortnight. M. Nicaise, at the same meeting, described a case of fibrous tumor of the umbilicus, in removing which he had to open the peritoneum; the patient made a good recovery. Mr. Francis Mason¹ has recorded a case of papillary tumor four inches in length and one and a-half inches in width, which he removed from the abdominal wall of a girl aged 20. The growth was congenital, and, with a similar one about the size of a pea, close to it, had never given the least pain or inconvenience locally, except through a slight, offensive discharge, which was sufficient however to prevent her from keeping a situation as domestic servant. The structure was of the ordinary warty character. The growth was excised, and five years afterwards it was known that there neither had been nor was then any recurrence.

LARGE SARCOMATOUS TUMORS of the abdominal wall are sometimes met with, and may be successfully removed even though the peritoneum is extensively implicated.² My Colleague, Mr. A. Clark, removed a growth of this sort which had commenced below the level of the umbilicus, on the deep aspect or in the substance of the rectus muscle, and which, after penetrating the parietal peritoneum, had involved the subjacent abdominal viscera. The whole of the disease could not be removed at the operation, and the patient died in forty-eight hours.

FLESHY POLYPI OF THE UMBILICUS originate in an error in cicatrization, and are first noticed after the umbilical cord falls off. Their size varies from that of a currant to that of a date-stone or larger, their surface is moist, and they

¹ Trans. Path. Soc. Lond., vol. xxii. p. 229.

² Lond. Med. Record, May 15, 1883, p. 170.

are generally more or less pedunculated and of a bright-red color, though sometimes they are wart-like, or like a granulation-tumor. A small aperture, admitting a probe, is usually seen on the summit, and when the polypus is associated with a fecal or urachal fistula, as it sometimes is, the probe can be passed inwards a long distance. Rarely, they bleed to a dangerous and even a fatal extent. Microscopically, they consist of branched mucous glands having a fibro-nucleated stroma, and are covered and lined by epithelium of the columnar type. The *treatment* consists in ligaturing the pedicle and allowing it to dry up and fall off. If a fistula coexists, the ligature may also cure it. Mr. Holmes¹ reports a case of biliary fistula at the navel, in a boy aged ten years, in which discharge of pure bile followed the removal of one of these fleshy polypi.

HÆMORRHAGE FROM THE UMBILICUS.—There is a rare form of hemorrhage from the umbilicus of new-born infants, which is almost universally fatal. It affects boys twice as often as girls, and is more fatal in the former. Its cause is a vitiated state of the blood, due to jaundice, or to a transmitted hemorrhagic or syphilitic dyscrasia, whereby the natural obliteration of the umbilical arteries is prevented, owing to the non-coagulating character of the blood. Hemorrhage of a most intractable character, either traumatic or idiopathic, may occur about the insertion of the cord before its detachment, but it generally occurs after the separation, and when the umbilicus has nearly cicatrized; thus it is within eighteen days from birth, and generally in the second week, that it commences, whilst the cord separates about the fifth or sixth day. It is fatal, on the average, within forty-eight hours; but many cases have lingered on for many days. The children have, as a rule, been well formed, have been born of healthy parents and in natural labor, and have appeared healthy at and for a few days after birth; then infantile jaundice, and in some instances purpura, has set in and preceded the hemorrhage. A combination of jaundice and purpura seems to be a precursor of certain death. In a large number of cases there has been a hereditary tendency to bleed, a tendency which, as experience has amply shown, more frequently affects the males of a family. The *treatment* consists in the use of mild but active cathartics, and of anti-hemorrhagic remedies. Compression and styptics (a piece of sponge soaked in a saturated infusion of alum or matico) are useful, but have rarely been permanently successful. Cauterization has done harm, and no good can be expected from it in any form. The ligature of the umbilicus *en masse*, with two needles transfixing it at right angles, offers the best chance of permanently arresting the bleeding.²

SUB-PARIETAL CONTUSION AND RUPTURE OF VISCERA.

It has been said above, and I must now repeat, that every injury to the abdomen, however slight it may appear at the time, ought to be watched with apprehension and treated with care. What is true respecting injuries to the head is equally true respecting those of the abdomen, namely, that unexpected symptoms may arise, and death ensue, from a slight blow; but that, on the other hand, violence, apparently severe, may be neither attended nor followed by any grave effect. Whilst therefore we are encouraged to

¹ System of Surgery, 3d ed., vol. iii. p. 793.

² For further information on this subject, see a very valuable paper by Dr. Stephen Smith, in the New York Journal of Medicine, New Series, vol. xv. p. 73; and a paper on "Umbilical Hæmorrhage," by Dr. Thorold, in the Edinb. Med. Journal, September, 1863, p. 272.

hope for the best, it is our bounden duty in the interest of the patient to be suspicious of the worst, and to adopt precautions accordingly.

It is not difficult to understand why grave results follow from slight injuries to the abdomen or to the head. We have but to remember the highly important nature of the structures contained within those cavities, their proximity to the surface, their large blood-supply and consequent liability to hemorrhage, their proneness and that of their serous coverings to inflame after injury, and the necessity of their integrity for the due performance of the complex processes of life—in fact their anatomical relations and their physiological functions—to realize the risk of injuring them.

Blows, kicks, or falls on the abdomen, the passage of a wheel over it, or some compressing force applied to its surface, are the general causes of sub-parietal contusions and ruptures of the abdominal organs; and these injuries frequently occur without the trace of a bruise, wound, or mark of any sort, upon the surface of the abdomen.

To facilitate description of contusions of the abdomen attended with sub-parietal injuries to the viscera, we may group together the contents of the abdomen after the following plan: 1. The nerve structures, chiefly of the sympathetic system, and especially the great central plexuses, the solar and hypogastric. 2. The bloodvessels of the general and portal systems, and more especially the aorta and vena cava, the hepatic, splenic, renal, and mesenteric vessels. 3. The stomach and small and large intestines. 4. The solid organs, made up largely of bloodvessels. 5. Certain receptacles and tubes, such as the gall bladder, the urinary bladder, and the uterus, which vary much in size at different times, and the ureters, Fallopian tubes, vasa deferentia, and thoracic duct. 6. The peritoneum, which extends over the whole surface of the cavity, and more or less completely envelops the several contents.

Contusion of the abdomen attended with peritonitis, whether as the result of laceration of the peritoneum or not, will be considered under “traumatic peritonitis.” Contusion of the abdomen attended with injury to the sympathetic, and more especially to the solar plexus and its numerous branches, is supposed to be the explanation of those instances of sudden death from a blow on the epigastric and upper part of the umbilical regions, in which no morbid change, not even a trace of ecchymosis about the parietes, is detected after death. A blow on the pit of the stomach, or a “hit in the wind” as it is pugilistically called, causes sometimes so severe a shock as instantly to arrest the action of the heart, and death occurs from what seems a trifling blow. Sir A. Cooper, though not an eye-witness of the event, described such a case as happening near the East India House; Dr. A. Swaine Taylor has referred to one or two somewhat similar cases; and Surgeon Arthur Harding has contributed another.¹ Reference has already been made to this subject in the section on “contusion of the abdominal parietes.” Contusion and rupture of several of the organs contained in the fifth of the above groups will receive notice in other articles, and there only remain therefore, for present consideration, injuries without external wound: 1, to the bloodvessels; 2, to the stomach and intestines; 3, to the solid organs; and, 4, to the gall-bladder, the hepatic and common ducts, the ureter, and the thoracic duct.

CONTUSION AND RUPTURE OF THE ABDOMINAL BLOODVESSELS.—The aorta, vena cava, celiac axis, mesenteric, spermatic, and other chief vessels of the abdomen, are ruptured either by a smart, forcible blow, or by a severe crush-

¹ Army Med. Department Report, vol. xxi., Appendix No. vi. 1881; and Holmes's system of Surgery, 3d ed. vol. i. p. 867.

ing violence, such as the passage of a wheel of a wagon, etc. In the case of the aorta the rupture is generally transverse, but occasionally oblique; sometimes it is a clean rent, sometimes irregular and angular; occasionally it is entirely across, but more frequently not; in some instances all the coats are torn, in others the internal and middle coats only are divided, and become inverted and retracted within the stronger outer coat in the same manner as after the employment of Fleet Spier's artery-constrictor.¹ In the Museum of the Middlesex Hospital there are two beautiful samples of this form of rupture. Instances of rupture of the vena cava have been recorded by Breschet, Richerand, Velpeau, and Poland. Poland² has also recorded a case of death from hemorrhage, from a branch or branches of the vena porta at their entrance into the liver. The woman was run over when intoxicated; there was no external sign of injury; she referred all her pain to the scrobiculus cordis and the left hypochondrium; but at the post-mortem examination there were three pints of coagulated blood in the abdomen, and copious effusion behind the peritoneum, derived from the torn vessels, but no laceration of liver or spleen, all the organs being healthy. Dr. McNaughton records a case of death from rupture of the right ovarian or spermatic vein.³ Prof. Gross cites a fatal case of laceration of the splenic vein.⁴ Veins within the abdomen have been known to burst spontaneously during the cold stages of ague.

One of the results of contusion of an artery is aneurism. This is more likely to follow if the inner coats are lacerated, and the external weakened but not torn by the blow. In the Guy's Hospital Reports for 1851,⁵ Dr. Lever records a case of aneurism of the common iliac, caused by a blow, in a female aged 33. Aneurism of the right superior mesenteric artery has arisen in the same way.

The *symptoms* will vary according to the size of the vessel injured, and will depend upon whether the rupture is complete and attended with hemorrhage, or incomplete and unattended by bleeding. If the rupture be completely through all the coats, and the vessel be of some size, hemorrhage, and collapse with syncope, will be extreme. If the rupture affect only some of the coats, or if a vessel be seriously contused without any of the coats being lacerated, hemorrhage will not occur; but the evil consequences of the injury will be shown at a later period in gangrene, or in the results of a diminished blood-flow owing to permanent narrowing of the calibre of the vessel at the contused part, or in the formation of an aneurism. Usually these injuries to the vessels are complicated by lesions of other organs, which add to the fatality of accidents sufficiently dangerous and fatal of themselves. It is not seldom that both artery and veins are injured together, and then if death does not ensue from hemorrhage, it almost certainly will from gangrene.

The *diagnosis* of these injuries is difficult, and is often complicated by the presence of other lesions, produced by the same accident. The *prognosis* is most unfavorable, the least dangerous being the incomplete ruptures, and the contusions without rupture of any of the coats.

Treatment.—If there be time for the adoption of any line of treatment, this should consist in the maintenance of absolute rest in the recumbent position, in a cool air, with the application of ice to the abdomen; opium should be given to relieve pain and quiet the circulation. With evidence of hemorrhage continuously going on, or recurring a few days after the injury, the

¹ See Figs. 400–406, Vol. II., page 548, *supra*.

² Prize Essay.

³ Edin. Med. and Surg. Jour., 1841, p. 253.

⁴ System of Surgery, 5th ed., vol. ii. p. 687.

⁵ Guy's Hosp. Reports, 2d series, vol. vii. p. 130.

abdomen should be opened and the bleeding vessel searched for. Desperate as such a course may seem, it is preferable to allowing the patient to die from hemorrhage which might prove controllable. But the bleeding may be so sudden and profuse that no time is allowed for the adoption of any treatment. Such was the condition in the case of laceration of the aorta, recorded by M. Legouest.¹ A farrier received a kick from a horse, near the umbilicus, causing a transverse laceration of the left side of the aorta, one-fourth of an inch in length, and three fingers' breadth above the promontory of the sacrum; the hemorrhage was rapidly fatal.

CONTUSION AND RUPTURE OF THE STOMACH AND SMALL AND LARGE INTESTINES.—*Contusions of the gastro-intestinal tube* are apt to be followed by acute or chronic inflammation of some or all of the coats of the part injured. Traumatic gastritis, enteritis, cæcitis, and colitis, whether of the acute or chronic form, present the same symptoms as when occurring idiopathically or from poison. The symptoms of these diseases are to be found described in works on medicine, but as they occasionally occur in surgical practice, it is necessary for the surgeon to be familiar with their diagnosis and treatment.

Briefly, then, it may be said that *acute* inflammation of the stomach or intestines is attended by severe local pain of a persistent character, but interrupted by paroxysms of pain still sharper; by acute tenderness on pressure, much febrile disturbance, thirst, nausea, vomiting, and abdominal distension; by hurried and often painful respiration, a small, frequent, wiry, or thready pulse, constipation, scanty and high-colored urine, a feeling of inward burning, exhaustion, and a countenance pinched and expressive of great distress. If the case goes on to a fatal termination, the patient rapidly emaciates, and has a dark, sunken look about the eyes; his hands and feet become blue and cold; cold sweats suffuse the face and extremities, the pulse intermits, hiccough sometimes occurs, a drowsy stupor with wandering delirium supervenes, the sphincters relax, possibly all pain ceases, and the patient, having been brought to death's door by way of asthenia, often hovers before it for a longer or shorter time, and then, in a manner quite suddenly, vanishes through cardiac syncope. The diagnosis of gastritis, enteritis, etc., from local, acute peritonitis, is very difficult, and sometimes quite impossible; but from the point of view of treatment this matters little, since these affections are but peritonitis with something more—namely, inflammation of the areolar and muscular tissues, as well as of the peritoneal coat.

The symptoms of *chronic* inflammation of the various parts of the gastro-intestinal tube are frequently very obscure, and simulate chronic peritonitis. For their description we must refer to works on medicine. The surgeon must bear in mind, however, that chronic gastritis may run on into ulceration, sloughing, gastro-abdominal fistula, and permanent contraction from thickening of the coats, or from cicatrization after ulceration. Similar results follow from chronic inflammation of any part of the intestinal tube. Complete intestinal obstruction may be caused by the thickening and contraction of the walls of the intestine after contusion. Many years ago, a very typical case of this sort was communicated to the Académie de Chirurgie by M. Braillet,² and other somewhat similar cases have been recorded since.

Reference will again be made to gastric and fecal fistulæ arising from contusions and other injuries to the coats of the viscera.

Rupture of the stomach or intestines is probably more frequent, and certainly

¹ Chirurgie d' Armée, 2e éd., p. 372.

² Memoir of Hévin on Gastrotony. Poland quotes this case; see Guy's Hospital Reports, 3d series, vol. iv. p. 136, and Prize Essay, MS.

much more fatal, than simple contusion. Rarely is the rupture confined to one coat, either serous or mucous, but generally the whole of the coats are lacerated. *Rupture of the stomach* is more rare than rupture of the intestine, owing to its smaller extent and deeper position, when not distended, when also it is protected by the ribs and costal cartilages, and by the liver. Incomplete rupture of the stomach is occasionally found in persons who have died of rupture of other organs, or of other injuries. Sometimes the mucous, sometimes the peritoneal coat alone is lacerated. Poland writes:—

Rupture of the stomach may be complete or incomplete, affecting one, two, or more coats at a time. Devergie remarks: "If it be the outer coat, there are generally observed, and principally at the lesser curvature, five, twenty or thirty tears, with clean borders, half an inch to an inch long, without separation of the edges. Similar tears are observed on the mucous coat, and it is remarkable that these often exist just at the point opposite to the external tear. Their direction is from before backwards." He adduces several cases in support of this view; we, however, have only observed partial laceration of the peritoneal coat, to some extent, with considerable ecchymosis; here, however, there was rupture of the spleen as well. In another there was extensive laceration and hanging in shreds of the mucous lining of the stomach, caused by the wheel of a cart passing over the abdomen; here, also, there was extensive laceration of the liver.¹

Where all the coats are ruptured, death may ensue at once by shock or collapse, or precisely the same symptoms may occur as follow wounds of the stomach. The situation of a rupture of the stomach varies: it may be at the cardiac or pyloric extremity on either aspect, or along either curve. It may be torn quite across at the pylorus; or the rent may be oblique, or in the long axis of the viscus. The post-mortem records of the Middlesex Hospital contain the details of the case of a boy, aged nineteen years, who was killed in a railway accident: There was a linear rent in the stomach, $1\frac{1}{4}$ inches in length and extending through all its coats, about the middle of the great curvature; almost the entire stomach, with its contents, and the left lobe of the liver, were displaced into the left pleural cavity through an opening in the left side of the diaphragm, measuring 12 inches in circumference.

Rupture of the small and large intestines may be either partial or complete. Partial ruptures give rise to no special symptoms whereby they can be diagnosed, and they are not seldom healed by localized peritonitis. This is proved by what is observed after death, as well as inferentially from what is seen to exist in some cases of hernia and of abdominal section, which have ended in recovery, and in which considerable lacerations of the serous coat of inflamed and softened bowels, observed at the time of the operation, have been repaired. Cases in which bright blood has been passed by the rectum shortly after an injury over the colon or sigmoid flexure, by persons previously healthy, suggest that lacerations of the mucous membrane of the large gut may occur from contusion of the abdomen, and that such lacerations are readily recoverable. Complete rupture of the bowel may occur from very slight causes, especially if of the nature of a smart, quick blow upon the abdomen. Complete rupture does not necessarily deprive a person of the power of locomotion. Taylor refers to a case in which the duodenum was completely torn across, and yet the patient, a boy aged thirteen, walked a mile with but little assistance, and died in thirteen hours. He also refers to a case, in a young girl, in which the jejunum was ruptured by a blow with a pebble. Other cases are on record which prove that complete rupture of the intestine—that is, laceration through all its coats—may be followed for several hours

¹ Poland, Prize Essay; see also Guy's Hospital Reports, 3d series, vol. iv. pp. 132, 133.

by complete immunity from symptoms. In one case, a man whose ileum was rent in two places walked to bed and undressed himself.¹ Key has recorded the case of a man who continued at work, carrying sacks of flour to a vessel, after traumatic rupture of the bowel in a hernia. Dr. E. K. Sanborne had a patient who was struck on the abdomen by the handle of a hand-cart, and died in forty-six hours of complete rupture of the gut; but he was able to wheel his cart across a yard after the blow.² Dr. Bristowe³ records the case of a man who fell and suffered a circular laceration of the sigmoid flexure, half an inch in diameter, through which mucous membrane projected, and through which fetid gas and fecal matter had escaped into the peritoneal cavity. There had been no pain at first, and for three hours there had been no collapse. The accident happened at 5.30 P.M., at 9 o'clock collapse came on, and at 1 A.M. he was dead.

Complete division of the small intestine from a blow on the belly has been recorded, no effusion of the contents following. In one case the patient lived eight days, and, owing to the tight contraction of the circular fibres of each end of the divided gut, there was no escape of fecal matter.⁴ A similar, complete division of the cystic duct without the escape of bile, will be referred to hereafter.

Rupture of the intestine occurs at any part of the small or large bowel, from the commencement of the duodenum to the lower part of the sigmoid flexure. The *duodenum* being the most fixed portion of the intestine, might be thought to be most liable to rupture from injury; but its deep situation behind the liver and transverse mesocolon protects it. As a matter of fact, it is very rarely torn. Poland's⁵ collection of 63 instances of ruptured gut, contains only 4 cases of ruptured duodenum, all of which were fatal at periods varying from five hours to three days after the injury. The *jejunum* was ruptured 14 times out of the 62. In 7 cases the rent was near the duodenum, and in 3 the jejunum had been forcibly torn away at its junction with the duodenum, its most fixed point. In other cases of ruptured jejunum the rent was in the central or lower parts, and extended through from one-quarter to three-quarters of its circumference. The *ileum* seems to be about as frequently ruptured as the jejunum, or even more so; like the jejunum it may be completely torn across, or ruptured to any less extent of its circumference. The large intestine is not much more frequently ruptured than the duodenum or stomach, and very much less frequently than the jejunum or ileum. The *cæcum* is more liable to rupture than the ascending or descending colon. The *sigmoid flexure* itself may be ruptured, or it may be torn away from the rectum.⁶ Poland⁷ quotes five cases of ruptured large intestine out of sixty-three of ruptured gut; of these five, two were of the cæcum, two of the sigmoid flexure, and one of the descending colon. Morineau⁸ gives an instance of rupture of the *ascending colon*.⁹

The rupture may vary in extent from a mere pin-hole, to a rent two,¹⁰ six,¹¹ or more inches long in the stomach, or to a complete tearing asunder of the gut, together with its mesentery. If the rent is incomplete or very small.

¹ Poland, Guy's Hospital Reports, 3d series, vol. iv. p. 155.

² Agnew, Principles and Practice of Surgery, vol. i. p. 356.

³ Trans. Path. Soc. Lond., vol. ii. p. 94.

⁴ Ibid., vol. xii. p. 109.

⁵ Guy's Hospital Reports, 3d series, vol. iv. pp. 123 *et seq.*

⁶ Hole's case, Lancet, vol. i. 1851, p. 381.

⁷ Loc. cit.

⁸ Gaz. Méd., p. 788. 1852.

⁹ For references to several other cases, see Medical and Surgical History of the War of the Rebellion, Part Second, Surgical Volume, p. 22. To the vast amount of facts and references contained in this wonderful compilation I am deeply indebted.

¹⁰ Collins, Boston Med. and Surgical Journal, vol. lxxiii. p. 202.

¹¹ Roques, Jour. Gén. de Méd., etc., tome lxxv. p. 351.

and if the viscus is not much distended at the time, extravasation into the peritoneal cavity may not occur; otherwise the escape of some of the contents is all but inevitable, and death from intense peritonitis must follow. It is improbable that complete rupture of either the stomach or bowel, from contusion, ever takes place unless the viscus is more or less distended; and there are no facts to lead us to suppose that complete rupture without an external wound has ever been otherwise than fatal. Ruptures of the gastrointestinal tubes are more fatal than wounds of the same part.

Symptoms.—The immediate results of rupture of the gastro-intestinal tube are not the same in all cases; thus, in one instance, extreme collapse, sudden and excessive meteorism, intense suffering, and rapid death within an hour or two, will be witnessed; whilst in another the patient will be able to walk, or will be comparatively free from pain for a long time or altogether, and death may be delayed for three or four days. There are certain features common to rupture of the stomach and rupture of the intestine, and it will save repetition to consider both classes together. These symptoms may be divided into immediate and subsequent. The immediate symptoms are faintness and collapse, succeeded by intense pain which soon becomes agonizing, is of a burning character, and spread all over the abdomen; the face is anxious and assumes sometimes a hippocratic expression; the pulse may be slow, feeble, and intermitting, or it may be natural for a time, until peritonitis sets in; rigors occasionally occur; thirst is complained of, and vomiting takes place, first of the stomach's contents, then of blood, and lastly, it may be, of blood and bile; the abdomen becomes either tympanitic and tender, or flat and rigid from muscular contraction; finally, there may be retention of urine. The subsequent symptoms are such as are excited by traumatic peritonitis, and will be described in their proper place.

Diagnosis.—This is usually not difficult. Prolonged collapse, sudden tympanites, agonizing pain, acute tenderness of the abdomen with, probably, absence of external injury, blood in the vomited matter or in the stools, but without evidence of marked internal hemorrhage—these, following the receipt of a blow upon the abdomen, are very characteristic symptoms, though they are not all uniformly present. Distinction must be made between cases of primary rupture, which at once present such symptoms as the above, and cases of perforation of the coats which follow several days—it may be thirteen or fourteen days—after an injury, and which are due to ulceration of the contused parts of the viscera. The symptoms of the latter cases are for a time insidious, but as soon as perforation is approaching, the collapse and abdominal pain and distension become well marked. If violence is inflicted upon the inguinal region, or upon a scrotal hernia, the symptoms of ruptured bowel may be erroneously referred to damage to the testicle or cord, but the hippocratic expression, together with the continued and increasing severity of the symptoms, will sufficiently indicate the more serious nature of the accident. The symptoms following a bruise of the intestine may simulate rupture of the bowel, but they are less severe, more transient, and more amenable to mild and soothing treatment. It is well for the surgeon to bear in mind that instant death may arise from the sudden perforation of a cancerous or simple ulcer of the stomach or intestine, and that as the death-stroke may be followed by a fall, doubt may possibly be raised as to the cause of the rupture, just as it is sometimes raised in cases of apoplexy and falls on the head, as to whether the extravasation is due to the fall, or the fall to the extravasation. A post-mortem examination will however clear up the question in the case of the intestine. In a case related by Guthrie, of a boy who was struck in the abdomen by a piece of wadding discharged from a gun, and who then fell from a tree and shortly died of ruptured ileum, a nice medico-legal point might have

been raised, namely, as to whether the fall or the blow from the wadding was the cause of the rupture.

Perforation of the stomach by gastric solution has been mistaken for rupture of the organ. Such a mistake might lead to serious consequences if an injury had been inflicted by another individual prior to the patient's death.

Prognosis.—It has been already stated that death is almost the inevitable termination of rupture of the membranous viscera. It may occur either in the primary stage, from collapse, or in the later stage, from peritonitis, or from intestinal obstruction due to contraction of the injured bowel; and it has been caused some weeks after the closure of the rent by pyæmia. If recovery takes place, it is because the rent is very small and soon closed by adhesions, or by prolapse of the mucous membrane, or by the opening becoming plugged by a mass of omentum, thus preventing the escape of the visceral contents, as in the case of Jobert (de Lamballe). Death after rupture of the stomach or duodenum occurs generally in from three hours to five days, but it is possible that some of the cases of supposed recovery from chronic gastritis have really been recoveries from slight or partial rupture, in which the lacerated coats have been healed, or glued to the surrounding parts by traumatic peritonitis. Poland¹ gives abstracts of 64 fatal cases of ruptured stomach and bowels, and out of 57 in which the time of death is stated, 10 were fatal in five hours, 17 in from five to twenty-four hours, 20 in from twenty-four to forty-eight hours, 9 between the third and sixteenth days, during the period of repair, and one after two months. Stromeyer² cites a case of abdominal contusion in which hæmatemesis recurred on the fourteenth day, and in which, at the autopsy, a rupture of the stomach was found.

Treatment.—Every care must be taken to keep the injured viscus absolutely quiet, so that repair may be effected. To this end, the first and most essential rule to observe is, "Never give a drop of fluid or a particle of solid food, for forty-eight hours at least—this is the golden rule."³ After this period, small quantities at a time of food, such as jelly, beef tea, or milk, may be taken by the mouth. There is no doubt that the chances of recovery have been quite destroyed by the neglect of these precautions, as the presence of brandy and water, and of castor oil, administered after the accident and found after death floating freely amongst the coils of intestines within the peritoneal cavity, has too plainly proved. Small fragments of ice, or a little piece of pellitory root to suck, or acidulated water, painted from time to time on the fauces, will allay thirst. Stimulants and purgatives must be avoided. Poland,⁴ in drawing attention to this class of injuries, writes: "We have been mainly influenced by the fact that much injudicious and careless (we might almost say reckless) treatment has been resorted to. In the numerous instances here collected, we have sad specimens of the action of purgatives in hurrying the unfortunate patient to a more speedy and inevitable death." The recumbent position, with the knees raised and supported by a pillow, must be observed; subcutaneous injections of morphia, or opium in small and frequently repeated doses, should be given; and hot fomentations or poppy-head stupes should be applied to the abdomen. As retention of urine is prone to occur after these as after most other injuries, this should be looked for and relieved if necessary by the catheter. If the patient survives the first shock of the injury, and peritonitis or intestinal obstruction supervenes, the treatment requisite for those conditions must be adopted.

¹ Guy's Hosp. Reports, 3d series, vol. iv. p. 123.

² See Med. and Surg. Hist. of the War of the Rebellion, Part Second, Surgical Volume, p. 22. Dr. Otis gives references to several cases of rupture of the stomach and intestines.

³ Poland, loc. cit., p. 129.

⁴ Ibid., p. 167.

The question of laparotomy ought to be considered, for though the difficulties both of diagnosis and of discovery of the ruptured point are great, yet nothing can be hoped for from expectant treatment if the rupture is complete and extensive through the bowel's coats. Though life in some cases has been prolonged for many days, the result is death, though the end may be delayed.

Prof. Albert,¹ of Vienna, has, for some years past, laid it down as a rule, that no clearer indications for laparotomy can be furnished than those given by rupture of the intestine.

Ruptures of the Omentum and Mesentery.—Such lacerations, though rare, occur occasionally without any external mark of contusion of the parietes. Prof. Gross² mentions a fatal case of rupture of the omentum, and in the History of the War of the Rebellion an interesting example of rupture of the mesentery is noted, in which some of the intestines became strangulated in the rent. A second case, if not of rupture at least of contusion of the mesentery, followed by abscess in the abdominal wall and mesentery, and by suppurative peritonitis, is related in the same work. The following cases are taken from the Post-mortem Record of the Middlesex Hospital:—

Rupture of Mesentery and of Inner Coat of Aorta, with Retroperitoneal Extravasation of Blood.—In December, 1880, a man, aged seventy, was admitted into the Middlesex Hospital, under the care of Mr. Hulke, with fractures of the fifth, sixth, seventh, eighth, and ninth ribs on the right side, and died the following day. There were some slight cutaneous bruises, and at the post-mortem examination some blood was found extravasated into the muscles of the left lumbar and iliac regions, and a considerable quantity into the muscles and tissues about the fractured ribs. The visceral and parietal peritoneum showed signs of recent, general peritonitis, most marked on the left side of the abdominal and pelvic cavities. Pus was beginning to form upon some of the coils of intestine. Nearly a pint of blood was found in the peritoneal cavity, and a large clot was between the left lobe of the liver and the diaphragm. The blood had come from ruptured vessels of the mesentery of the ileum, near its centre. A rent existed in this part of the mesentery, three and one-half inches in length, its edges ragged, and covered with adherent blood-clot. At several points small ecchymoses were seen in the mesentery; two of these, larger than the others, were nearly the size of florins. Two inches below the origin of the cœliac axis, a rent half an inch in length was found in the inner coat of the abdominal aorta; no extravasation of blood between the coats of the aorta had occurred at this spot; the vessel, however, for five inches of its course along the abdomen, was surrounded by dark clot, the source of which appeared to be one of the lumbar arteries which was full of clot, though this could not be absolutely decided. (Post-mortem Report, No. 205. 1880.)

In another case, admitted into the Middlesex Hospital under the care of Mr. Lawson, in January, 1879, the mesentery, which was fairly loaded with fat, was torn in three places. The largest of these lacerations extended about half way between the ileum and the spine, and admitted of the passage of four fingers; the margins of the rent were ragged, and blood was extravasated between the folds of the membrane. The other two rents were the size of sixpences, and were close to the larger one. There was no rupture of intestine or other organ. A quantity of blood was in the peritoneum, and peritonitis had commenced. The man died on the second day. (Post-mortem Report, No. 4. 1879.)

More or less severe extravasation of blood must be looked for in these accidents, and is most likely to prove fatal in a few hours. If life is prolonged, the edges of the wound may be healed by adhesions with adjacent parts, but if suppuration once occurs, it is prone to spread wide and far in the loose tissues of either mesentery or omentum.

¹ Wien. med. Woch., No. 47. 1881.

² System of Surgery, vol. ii. p. 679.

Contusion and Rupture of Hernia.—Cases have been reported by S. Cooper,¹ Watson,² Poland,³ and others, of rupture of the intestine from kicks or blows inflicted upon individuals the subject of hernia, though the part of the bowel ruptured was not that contained within the hernial sac. Such accidents have more frequently happened to men with inguinal or scrotal herniæ than to women; but one case, which was the subject of medico-legal inquiry, occurred in a woman with femoral hernia. This case, which is reported by Watson, was that of a woman who was struck by her husband on the abdomen, and died in twelve hours; the ruptured bowel was at a distance from the hernia, but opposite to a bruise on the abdominal wall; and as there was no fecal matter in, nor inflammation of, the sac, the husband was convicted. The following case was under the care of Mr. Hulke:—

A man, seventy years of age, was brought into the Middlesex Hospital on the 8th of February, 1881, with fracture of the pelvis and rupture of the urethra, for which perineal section was performed. He died the same day. At the post-mortem examination, a hernial sac in the right inguinal region was found to contain coils of ileum about eleven and one-half inches long, and at the entrance into the sac a transverse rupture of the gut had occurred, the coats being divided almost as cleanly as if they had been cut. Some fluid feces had escaped into the peritoneal cavity, and had set up acute general peritonitis; the intestines were distended with flatus and fecal matter.

Another class of cases, and one to which Aston Key⁴ and Poland⁵ have drawn special attention, is that in which the portion of the bowel within the hernial sac has received the blow. These injuries also occur chiefly in males with inguinal, or more especially with scrotal herniæ. In some cases the hernia has been reducible, and a truss has been worn, but, the blow having forced aside the pad of the truss, the bowel has received the effects of the violence. In other cases, the violence has been received directly upon an irreducible hernia; in a few, the injury has been inflicted whilst the bowel has been held in place by a truss. The injury may result in (1) contusion, followed by inflammation of the coats of the intestine, and of the sac; (2) contusion, followed by sloughing of the intestine, if the vitality of its coats has been destroyed; (3) rupture of the bowel. These three conditions are attended by the symptoms which arise in cases of corresponding injury to bowel not contained within a hernial sac, with, generally, this additional one, namely, that the soft parts about the hernial region become red and œdematous, and may threaten to or do actually burst. If the bowel have ruptured, the fecal extravasation, though it takes place first into the sac, will soon find its way into the general cavity of the peritoneum, unless an incision be made into the sac as in operating for strangulated hernia.

Prognosis.—In all the cases of which I am aware, in which the bowel has been ruptured by the injury, death has followed. In two cases reported by Key, in which, after injury to the hernia, acute inflammatory symptoms and vomiting set in, the sac was laid open, and, though the bowel subsequently sloughed, the resulting artificial anus closed spontaneously, and complete recovery took place, in one case in four, in the other in ten weeks.

Treatment.—In all cases in which a hernia has been injured, the hernial sac should be laid open if there be severe local or constitutional symptoms, whether the bowel be in the hernial sac or not when the patient is seen. Reduction of the hernia by taxis should never be attempted if there be or have been symptoms indicative of severe contusion of the bowel. It may happen that

¹ Dictionary of Surgery.

² Treatise on Homicide, pp. 77 *et seq.*

³ Guy's Hosp. Rep., 3d ser., vol. iv. p. 155.

⁴ *Ibid.*, 1st ser., vol. vii. pp. 264 *et seq.*

⁵ *Ibid.*, 3d ser., vol. iv. pp. 157 *et seq.*

the symptoms of severe inflammation of the coats of the bowel arise after reduction has been effected, in a case in which the slowness of the shock and the rapidity of the reaction dissipated all fear at the time, and induced the surgeon to employ a gentle taxis. Aston Key, however, was of opinion that in such a case the danger of fecal extravasation would not be increased by the replacement of the injured bowel near the neck of the sac; for should sloughing ensue, the slough might be walled in by adhesions of the surrounding peritoneum, and fecal extravasation would be thereby prevented; or if the salutary process of adhesion failed to insulate the slough, the sac would receive the fecal matter, and quietly give intelligence of the mischief by the tumefaction which would ensue in the parts outside.

RUPTURE OF THE SOLID VISCERA.—Rupture of the solid viscera may occur in the same manner as sub-parietal rupture of the hollow viscera or blood-vessels, without any wound or visible contusion of the abdominal wall. Blows, falls, kicks, or compression, are the common causes of such accidents. It is stated by Taylor,¹ on the authority of Male,² that the liver may be ruptured merely by a sudden action of the abdominal muscles; and Taylor likewise refers to a case³ in which a fall on the feet from an elevation produced laceration of this organ. Sometimes two or more of the solid viscera are lacerated by the same violence. In a man brought into one of my beds at the Middlesex Hospital, over whose body a wagon had passed, there were found after death lacerations of the liver, spleen, left kidney and supra-renal capsule, left lung, and pericardium, as well as several broken ribs, and a comminuted fracture of the tibia. Any of the solid organs of the abdomen may be torn in one place, or in several; their peritoneal coat may not be lacerated, though most frequently it is. The liver, the spleen, and more rarely, but still occasionally, the kidney and its supra-renal capsule, may be injured by broken ribs, but if so, the diaphragm is, as a rule, perforated also. I have before me as I write the notes of several such cases taken from the records of the Middlesex Hospital. Ruptures of these organs are generally fatal from hemorrhage and shock within a few hours; occasionally life is prolonged for two, three, or more days, and is terminated by recurrent or slowly continued hemorrhage, or by peritonitis. Mackmurdo⁴ had a case in St. Thomas's Hospital, of extensive laceration of the liver, and the patient survived seven weeks. The man, aged twenty-three years, remained collapsed for forty-eight hours, and then slowly revived. Peritonitis supervened, and the abdomen swelled; there was distinct fluctuation detected on the right side of the belly; and the patient died from suppression of breathing due to the upward displacement—as high as the third rib and second dorsal vertebra—of the right leaflet of the diaphragm and right lung, by a circumscribed collection of serum, blood, blood clot, and bile-stained lymph. Recovery may, however, be the result if the injury is confined to one organ, and is not very extensive; when the peritoneal covering is unbroken, the chance of recovery is greater, although abscess of the liver may result. As it is quite impossible to diagnose laceration of the substance, unaccompanied by laceration of the capsule, of these organs, there is always the suspicion, in cases which recover, that the injury has been merely a contusion followed by localized peritonitis, unless abscess of the injured organ has formed. The proof of the cicatrization of wounds of the solid viscera is found in persons who have lived for some weeks after the rupture, and have died of suppuration or of some associate injury; or who have altogether recovered from the injury, and have subsequently died

¹ Med. Jurisprudence, p. 449. 1865.

² Epitome of Juridical or Forensic Medicine, p. 119.

³ Ann. d'Hygiène, t. i., p. 133. 1846.

⁴ Trans. Path. Soc. Lond., vol. iii. p. 344.

from some other cause. Such was the case reported in a paper by Athol Johnson,¹ of a man aged 38, who ruptured his liver and right kidney, and fractured his seventh cervical vertebra. He died from the effects of the injury to the spine three weeks after the accident, and at the post-mortem examination it was seen that an extensive rupture of the upper surface of the right lobe of the liver, five inches in length, "was perfectly united, with the exception of some few points where the peritoneal coat still remained broken; but no lymph was found on the serous membrane, which retained its polished appearance. The rupture did not extend very deeply into the organ. Several ruptures beautifully united, but not extending more than two lines in depth, were found on the anterior surface of the right kidney; no inflammation existed about this organ." In a case reported by Dr. Walter Fergus, there was also fair evidence of repair.²

Rupture of the Liver.—The liver may be completely broken through, or the rupture may be limited to either its upper or lower surface. Out of twenty-two fatal cases of injury to the liver which occurred at Guy's Hospital, between 1867 and 1872, the damage in the greater number (fourteen) was extensive. In six cases the liver was partially or entirely divided in an antero-posterior direction; in eight it was severely lacerated in various directions; and slighter injuries of the upper surface occurred in only two, and of the under surface in only three of the number.³ The liver, as I have seen, may be divided from before backwards through its whole thickness; or an irregularly shaped mass may be broken away from the rest and found lying loose in the abdomen; or the gall-bladder, with the adjacent part of the liver-substance, may be rent off from the surrounding parts. Dr. Alexander Kilgour⁴ has recorded the case of a man who was said to have had his belly jumped upon, and who died in great pain on the second day after. At the autopsy, the gall-bladder, half distended with bile and blood, was found loose and quite separated from its connections. Some coagula, and one hundred and twenty ounces of fluid blood, were found in the peritoneal cavity, and upon the rough, under surface of the liver from which the gall-bladder had been torn away.⁵ A very frequent situation of rupture from external compression, when the ribs are not broken, is the upper surface of the right lobe near its posterior border; the laceration in these cases may be transverse, or stellate, and of several inches in length, with ragged edges, and it may extend deeply into or through the liver-substance. It would seem that in these cases the injury affects, not as might be expected the part compressed, but the most protected part, owing to the forcible doubling up of the liver upon itself. Sometimes it is the back part of the under surface of the right lobe which yields, and then large quantities of blood are poured into the cavity of the peritoneum, in front of and behind the stomach. When the upper and back part of the right lobe is torn, the effused blood may push up the diaphragm so as to make it encroach considerably upon the pleural cavity, as in Mackmurdo's case already referred to.

When injured by the broken ends of ribs, there will be two or more superficial rents or punctured wounds, which at the post-mortem examination will be found covered with blood-clot. In a case recently in the post-mortem room at the Middlesex Hospital, the liver of a man who had been found dead in the street, was marked by one oblong, sub-peritoneal contusion,

¹ Med.-Chir. Trans., vol. xxxiv. p. 55.

² Ibid., vol. xxxi. p. 45.

³ Dr. Frederick Taylor, Guy's Hosp. Rep., 3d ser., vol. xix. p. 261.

⁴ Edinburgh Med. and Surg. Journal, p. 352. 1841.

⁵ A similar case, recorded by Ogston, is referred to in the section on Rupture of the Gall-bladder.

attended with pulping and effusion of blood, five inches long, exactly corresponding to the shape and position of the ninth rib, the tissues on which were also ecchymosed. I have reported a remarkable case of slight rupture of the liver-substance at a part where a hydatid cyst had been developed. The cyst was also ruptured and detached from the surrounding liver-tissue, and some hemorrhage into it had occurred from the torn surface of the organ. The liver-capsule was quite intact. The patient died of shock. Ogston¹ says that of 26 ruptures of the liver, in 9 the seats of rupture were in the right lobe, in 11 in the left lobe, and in 6 in the central parts. Of these, 9 took the antero-posterior direction and 2 the transverse, the others being irregular.

It is curious that, though the liver-substance is often torn right up to the side of the hepatic portion of the vena cava, or the laceration even runs parallel for a long distance with a large branch of the hepatic vein, the coats of these vessels so often escape injury. A case related by Dr. Pearson,² and several others on record, justify this statement. In Pearson's case, remarkable for more reasons than one, the liver was completely divided obliquely, and the two portions were held together only by the vena cava and the trunks of the venæ cavæ hepaticæ. In a man brought into the Middlesex Hospital dead, the liver was lacerated completely across its right lobe, the portions of which were only held together by a few vessels which had escaped being torn. I have notes of other cases in which the same condition was found.

The *symptoms* of ruptured liver are extreme pallor and coldness of the surface; difficult and short, or sighing, breathing; small, feeble pulse; abdominal pain and distension, the distension not being entirely tympanitic; sense of sinking and vomiting, with sometimes great thirst; and occasionally itching of the skin, and jaundice if the patient live more than twenty-four hours. Diabetes has been said by Bernard to follow injuries to the liver. If death does not occur from hemorrhage or collapse, there are the risks of peritonitis, and at a still later period of abscess of the liver, or of abscesses between the liver and some of its surroundings. After peritonitis has set in, there will be great tympanites, and as this subsides, dulness on percussion may be detected either in the flanks or in some circumscribed area about the liver. This dulness is due partly to extravasation, and partly no doubt to inflammatory effusion, and it may disappear in part or entirely if the patient survive a few weeks.

Rupture of the spleen is less common than rupture of the liver, and when it occurs it is frequently accompanied by injury to other abdominal or thoracic organs, and especially to the liver itself. It is often associated with fractured ribs. Spontaneous rupture of the spleen, according to Rokitansky and others, occurs in typhus and typhoid fevers, cholera, and the hot stage of ague, and leads to death from hemorrhage. Hemorrhage is the chief cause of death after traumatic rupture of the spleen, but though this organ is more vascular than any other in the abdomen, uncomplicated injuries to it are not as quickly fatal as injuries to the liver. This, perhaps, is attributable to the great elasticity of the splenic capsule and trabeculæ. If the splenic vein or artery be torn, death will be almost instantaneous, as in the case, detailed by Hennen,³ of the soldier who received a violent blow in the abdomen whilst fighting, and died in a few minutes from rupture of the spleen and splenic vein. In another case,⁴ rapid death from hemorrhage followed after rupture

¹ British and Foreign Med.-Chir. Review, vol. xxxix. p. 204. 1867.

² Medical Transactions published by the College of Physicians in London, vol. iii. p. 377.

³ Op. cit., p. 445.

⁴ Medico-Chirurgical Review, October, 1839.

of the spleen, but here the spleen was enlarged and very soft; the rupture was caused by a blow from a boy who in stature scarcely reached the waist of the man he killed. M. Vigla¹ and M. Collin² have published exhaustive papers on ruptures of the spleen, in diseased subjects, from muscular contraction or very slight external violence. If death from hemorrhage is escaped, abscess, and, less frequently, peritonitis, may cause the fatal result.

In a case reported by Mr. Davy,³ the portion of the spleen corresponding to the suspensory ligament was completely crushed off from the rest, and an antero-posterior rent nearly severed the remaining five-sixths of the organ at its middle. There were three short, linear rents in the splenic capsule, and the liver also was ruptured. Death occurred in two hours. There can be no doubt that in some instances rupture of the spleen, as of the liver, has been an after-result, and due to some movement of the patient whereby the broken end of a rib has been driven into the organ. Such a case was under the care of Mr. Campbell de Morgan,⁴ in the Middlesex Hospital, in 1872:—

A man, aged thirty-two, fell 25 feet, broke several ribs, and received other slighter injuries; emphysema followed on the left side; and he was sick, thirsty, suffered much pain in the præcordia, and could not pass his urine, but quickly rallied, and on the following day was doing well; thus he continued until the following day, when he was seized with delirium tremens and struggled violently; he then sank rapidly and died the next morning. The post-mortem examination showed that there had been a perforation of the ileum, which had become glued to the diaphragm, and that the broken end of a rib had projected through the diaphragm into a large rent in the spleen, from which extensive hemorrhage had taken place into the abdominal cavity. Both the clinical and post-mortem conditions of this case were opposed to the idea that the splenic lesion had been caused at the time of the accident.

The spleen, instead of being ruptured, may be displaced and reversed in position by an injury which ruptures other abdominal viscera. Thus, in a boy, aged nineteen, who was brought into the Middlesex Hospital, the stomach, diaphragm, and left kidney were ruptured; the stomach, with its contents, and the left lobe of the liver, were projected upwards through the rent in the diaphragm, and the lower end of the spleen was dragged upwards with the stomach into the chest.

The *symptoms* of ruptured spleen are collapse, pallor, and coldness from loss of blood; præcordial pain, gasping and shortness of breath; small, feeble pulse, sometimes very quick, from 120 to 150 beats in the minute; vomiting, thirst, and retention of urine. In many cases it is not possible to say what proportion of the symptoms is due to the rupture of the spleen, as there is so frequently a complication with other injuries within the abdomen and chest. Slighter cases of rupture of the spleen are likely to give rise to intra-peritoneal abscess, more especially in the left hypochondrium, between the diaphragm, stomach, and spleen.

Rupture of the Kidney.—It may be stated at once that hæmaturia following an injury to the loin, or lumbar region of the abdomen, is not necessarily symptomatic of ruptured kidney, and that on the other hand hæmaturia is not always a symptom when the kidney is ruptured; for the ureter may become completely plugged by clot, so that neither blood nor urine can get down to the bladder from the injured organ, and therefore no hæmaturia occur, and at the same time the kidney may be lost as an excreting organ.⁵

¹ Recherches sur la Rupture Spontanée de la Rate (Arch. Gén. de Médecine, 1843 et 1844).

² Des Ruptures Spontanées de la Rate (Mém. de Chir. de Méd. et de Pharmacie Militaires, 1855). For these and numerous other references on the subject of ruptures of the abdominal viscera, see Dr. Otis's exhaustive Surgical History of the War of the Rebellion, vol. ii.

³ Trans. Path. Soc. Lond., vol. xxi. p. 395.

⁴ Ibid., vol. xxiv. p. 173.

⁵ See Trans. Path. Soc. Lond., vol. xi. p. 140.

(1) *Hæmaturia* may denote simply *contusion of the kidney*. This I believe was proved by two cases in each of which a boy was run over by carriage wheels. In each case there was collapse and præcordial pain as well as pain in the affected loin. In one case there was no difficulty or pain in micturating throughout; in the other the catheter had to be used at first. In each case the urine was mixed with a large quantity of blood; in one the hæmaturia continued for three days, and in the other for four days. In neither case was there any contusion of the surface, nor any swelling in the loin. Both patients were well within a fortnight, though slight localized peritonitis occurred in one.

(2) An injury short of actual rupture of the pelvis of the kidney, or of the ureter, is that of *strain or laceration of the pelvis or ureter*, followed by adhesive inflammation and obliteration of the urinary duct. Hydronephrosis follows within a week or two, and leads to a tumor in the loin; and this after a succession of tapplings may cease to refill, owing to the complete destruction of the secreting substance of the injured kidney. An illustrative case of this sort is described by Mr. Croft,¹ and Mr. Stanley's² case was an exactly similar one to Croft's, and not one of ruptured ureter, as it is so often quoted as being. In other cases the kidney, in the course of months or years, becomes converted into a number of abscess-sacs, and the ureter atrophies after becoming quite impervious.³

(3) *Rupture of the kidney* is by no means a very infrequent accident, despite the protected situation of the organ, and its envelope of fatty areolar tissue. Nor is it by any means necessarily fatal, as is proved by the instances in which the injury has been felt through an external wound, by others in which urine and blood have been discharged through the loin, and by the case of the officer described by Hennen,⁴ in which the patient, who had been shot in the side, and afterwards suffered attacks of retention and urinous abscesses in the loin, completely recovered after a piece of cloth had been discharged through the urethra. Recovery may even follow complete division of the kidney and obliteration of the corresponding ureter. Such a case has been recorded in the London Pathological Society's Transactions,⁵ the patient subsequently dying of granular disorganization of the other kidney.

It is largely due to the plugging of the renal bloodvessels, and to the capacity of the other kidney, if healthy, for doing compensatory work, that so many recoveries from contusion, laceration, rupture, and puncture of the kidney take place.

The two chief conditions upon which recovery depends are the escape of the peritoneum, and that of the large branches of the renal artery and vein. If, however, a large branch of the renal artery be torn, and death does not quickly follow from bleeding, the gradually increasing hemorrhage is likely to lead by pressure to sloughing of the peritoneum, which may have escaped the original injury.

The kidney may be ruptured in several fashions, like the liver and spleen: there may be several small surface-tears, or the organ may be completely torn through, either transversely or longitudinally. Notes of each of these varieties are before me. It is more than probable, however, that some of the cases which have been regarded as examples of recovery from ruptured kidney, were not really cases of rupture: for example, a lad aged fifteen years had been run over, and for three days suffered pain in the hypochondrium, and vomited at intervals. There was blood in the urine on and after the day of

¹ Trans. Clin. Soc., vol. xiv. p. 107.

² Med.-Chir. Trans., vol. xxvii.

³ Mr. Haviland has recorded such a case. Trans. Path. Soc. Lond., vol. x. p. 209.

⁴ Op. cit., p. 455.

⁵ Trans. Path. Soc. Lond., vol. xi. p. 140.

the accident, and on the fifth day a quantity of granular matter, with uric acid crystals, a little blood, and some casts, were voided in the urine. On the seventh day the urine was clear, and on the tenth the boy seemed well and continued so afterwards. In this case, though the organ must certainly have been severely contused, one cannot but suppose that recovery would have been less rapid if the kidney had been ruptured.

After injury to the kidney or ureter, the symptoms are sometimes too obscure or insufficient for accurate diagnosis. In Stanley's¹ two cases, the urine was passed naturally and freely, and there were no symptoms leading to a suspicion of injury to either ureter or kidney, until a large tumor from which fluid containing urea was drawn away, formed in the right hypochondrium of one, and in the lumbar region of the other. In Poland's case,² which I had the opportunity of watching when Senior House Surgeon at Guy's Hospital, the precise nature of the injury remained doubtful up to the time of death, owing to the almost entire absence of urine during the six days the patient lived. The absence of urine was due to thrombosis of the renal vessels of one kidney, and the rupture of the pelvis of, and extravasation of urine from, the other kidney. Thrombosis of the renal vessels, as a result of violence to the lumbar region of the spinal column, is a possible occurrence, and should be remembered in relation to renal injuries, and to suppression of urine after injury to the back. Dr. Moxon³ has described a typical sample of nearly complete obstruction of both kidneys, in a man aged twenty-two who was struck in the back by an engine.

If after the collapse from an abdominal injury has passed off, pain in the hypochondriac or lumbar region continues, and there is vomiting and anxiety of countenance—if moreover the urine contains blood and blood-casts gradually diminishing in quantity for from three or four to six or seven days or longer, and if convalescence is slow—the suspicion that some contusion or laceration has occurred is justly aroused. If after the abdomen has been run over, or the person has fallen or been struck on the abdomen or loin, faintness, coldness, vomiting, and abdominal pain follow; if on the day of, or the day after, the accident, and whether the catheter be required or not, the urine is found to contain a quantity of blood and blood-clot; and if after several days blood-clots continue to pass, or pus as well as blood is voided in the urine; if moreover there is pain along the course of the ureter, with retraction of the testis, or a rigid and prominent state of some of the muscles of one side of the abdomen, with frequent desire to micturate; or, finally, if a tumor, dull on percussion, forms in the loin, or lumbar or hypochondriac region of the abdomen, accompanied or not with signs of local peritonitis, there are safe grounds for believing that either the kidney or its pelvis has been ruptured. The passage of blood-clot along the ureter into the bladder, is a source sometimes of great suffering, and of cystitis. The clots frequently assume the shape of the pelvis of the kidney, sometimes they are long, worm-like casts which have been moulded in the ureter, and sometimes they are blood-casts of the uriniferous tubes. The latter are frequently seen if looked for after slight injuries, such as contusions of the kidney. If the bleeding is not excessive, these various clots cease to pass after a few days.

A typical and instructive case, the notes of which I took when dresser to the late Mr. Hilton, was made the subject of a valuable clinical lecture⁴ by that philosophic surgeon:—

The case was that of a man aged twenty-one years, who was struck by the buffer of an engine. On admission, he vomited, and complained of great pain in the abdomen just

¹ Med.-Chir. Trans., vol. xxvii.

³ Ibid.

² Guy's Hospital Reports, 3d series, vol. xiv.

⁴ Ibid., vol. xiii. p. 9.

beneath the ribs, which was aggravated on the slightest pressure; the next morning vomiting and pain continued, but he was able to walk to the closet where he passed both urine and feces. On the day following the injury the catheter had to be passed, and a pint and a half of bloody urine was withdrawn. Some improvement followed on the fourth and fifth days, but on the eighth there was an increased quantity of blood in the urine. From the fourteenth day till his death, clots of blood accumulated in the bladder, and, besides obstructing the flow of urine, gave rise to agonizing pain in the hypogastrium and at the end of the penis. The pain in the penis was much relieved at times by merely passing a catheter a few inches down the urethra. A dull swelling formed in the left side of the abdomen; tympanites and delirium supervened; and the patient died on the twenty-sixth day. The left kidney was found ruptured across the middle, and the lower segment cracked transversely by very numerous, minute fissures. The left ureter and a branch of the left renal artery, on which was a small, recent aneurism, opened into a large cavity surrounding the broken kidney, and filled with grumous and vilely offensive blood, clot, and urine. The renal vein was not injured. In the peritoneum forming the anterior wall of this cavity, there was a ragged rent in a thin slough, through which offensive, bloody serum was found to exude into the peritoneal sac. No positive evidence of peritonitis existed.

Mr. Cock has recorded¹ a case of rupture of a single kidney in a lad eighteen years old, who fell from a height on to some rafters. Collapse and left-side abdominal tenderness ensued; and the next day the pain had increased—being very severe indeed on the left side—and all the ordinary signs of peritonitis had set in. On the introduction of a catheter only a small quantity of blood passed. Within a few days all symptoms of the original injury and of the subsequent peritonitis had subsided, except that the catheter, which was regularly required, withdrew nothing but blood. On the subsidence of tympanites a tumor was observed on the left side, and the patient died comatose on the eleventh day. The left kidney was completely divided through its pelvis, and the two halves were widely separated by a collection of blood and urine, which had been extravasated into the cellular tissue on both sides of the spine behind the peritoneum, upwards as high as the diaphragm, and downwards, in connection with the left psoas muscle, to the thigh. One of the smaller branches of the renal artery was open in the cavity. The kidney and ureter were nearly twice the normal size, owing to the rudimental state of the right kidney, and the congenital absence of the upper part of the right ureter, vein, and artery. In this case there was a large rent in the diaphragm, and the liver and stomach were displaced into the left pleural cavity.

Rupture of the Ureter.—There is no occasion to consider this apart from rupture of the kidney, as in the few cases on record the rupture was quite close to the pelvis of that organ; this is only what might be expected, since, excepting near the kidney, the ureter is so placed as to be well nigh secure from all external violence. Moreover, it is neither practicable nor necessary to make a distinction between the two sets of cases, either as regards symptoms or treatment. Poland² has put together six cases of so-called injury of the ureter. Two of them were examples of bullet-wound and not of sub-parietal rupture; and in only one of these, namely, the case of the Archbishop of Paris,³ in which the rupture was close to the pelvis of the kidney, was it certain that the ureter alone was injured; the other case is described by Hennen as a “complicated wound of the kidney,” and, as the patient recovered, it is a gratuitous assumption on Poland’s part to place it under wounds of the ureter. In two cases which I had the good fortune to follow from beginning to end, namely, Hilton’s, and Poland’s own, the kidney itself was ruptured; Hilton’s ought not to be included at all in Poland’s list, as it was not a case of rupture of the ureter, the kidney having been completely divided transversely across the pelvis, like some other cases on record;⁴ in Poland’s own case, in addition to the complete rupture of the ureter “just below the pelvis

¹ Trans. Path. Soc. Lond., vol. i. p. 293.

³ Gaz. des Hôpitaux, 1848.

² Guy’s Hosp. Reports, 3d series, vol. xiv.

⁴ See Taylor’s Medical Jurisprudence.

of the kidney," there was a rent in the back of the kidney, which had opened a branch of the renal vein and produced free bleeding beneath the investing fibrous capsule. One case reported by Stanley,¹ namely Vincent's, was not one of rupture of the ureter; a large irregular aperture was found in the pelvis of the kidney. Stanley's other² case ended in recovery, and the precise nature of the injury was therefore not ascertained; but there is nothing in the account of the case to point to the ureter, rather than to the kidney, and as rupture of the kidney is so much less rare than rupture of the ureter, the presumption is in favor of the former. Thus Poland's own case is the only one of the six in which there was a rupture of the ureter, as distinct from the pelvis of the kidney; it is, as far as I am aware, the only known case in which a sub-parietal rupture of the ureter has been proved. R. Harrison³ briefly records a case of "rupture of the ureter quite close to the kidney," that is, of the pelvis of the kidney; no details of the autopsy are given, though it is stated that the patient died the next day. "Some blood-stained urine was removed by the catheter, but beyond this there was nothing requiring any special comment as indicating the full extent of the damage."

The *prognosis* in rupture of the kidney, its pelvis, or ureter, is unfavorable, though less so than in rupture of the other abdominal organs. There are many cases published of recovery after injury, in which there is reason to believe that the kidney has been ruptured, and others in which healing has preceded death from other causes. The fatal result may be brought about early by collapse, hemorrhage, or peritonitis; or at a later date by pyæmia, cystitis, hectic fever, or exhaustion from abscesses excited by urinary extravasation, or by broken-down tissues or blood-clot; or death may occur from peritonitis or collapse set up by the bursting of the contents into the peritoneal cavity, through a sloughing of the limiting membrane of the abscess. If the ureter becomes permanently obliterated after injury, the kidney becomes destroyed, and death may be caused by suppuration of the organ. Injuries to the kidney, or to its pelvis, are likely to be complicated with injury to the peritoneum, or to be themselves complications of various kinds of fracture of the adjacent vertebrae.

Rupture of the Pancreas.—The pancreas is rarely ruptured. There are cases recorded by S. Cooper,⁴ Le Gros Clark,⁵ and Devergie;⁶ and Travers⁷ had under his charge, at St. Thomas's Hospital, a woman who when drunk was knocked down by the wheel of a stage coach, which did not pass over her. She lived a few hours; several ribs were fractured, the liver was lacerated, much blood had been effused, and the pancreas was completely torn through transversely. Ogston⁸ has also recorded a case in which pieces of the pancreas, together with other organs, protruded through a lacerated wound of the parietes. In all these cases the rupture of the pancreas was associated with rupture of other internal organs, and in all death occurred within a few hours. It is impossible therefore to ascribe symptoms specially to the injury of the pancreas, and there is no case on record in which Benjamin Bell's⁹ anticipation of what might happen from division of the pancreatic duct, has been realized, viz., greatly impaired digestion and intra-peritoneal collections of pancreatic juice requiring removal by the surgeon.

¹ Med.-Chir. Trans., vol. xxvii.

² Ibid.

³ Lectures on the Surgical Disorders of the Urinary Organs, p. 328.

⁴ Lancet, Dec. 31, 1839, p. 486.

⁵ Lectures on the Principles of Surgical Diagnosis, etc., p. 298. London, 1870.

⁶ Méd. Légale, 2e éd., t. ii. p. 94.

⁷ Lancet, vol. xii. p. 384. 1827.

⁸ Brit. and For. Med.-Chir. Review, vol. xxxix. 1867.

⁹ System of Surgery, 7th ed., vol. ii. p. 147.

Treatment of Rupture of the Solid Viscera.—In all cases in which contusion or rupture of the solid viscera of the abdomen is suspected, absolute rest in bed must be observed; the administration of solids by the mouth must be avoided; and anodynes should be subcutaneously injected, to ease pain and allay restlessness and tossing about. The internal use of gallic acid, ergot, and iron, has been recommended to check hemorrhage, and should be tried; or little pieces of ice may be sucked. Pain will sometimes be assuaged by strapping the affected side, a practice which assists in keeping all the parts quiet, and which by gentle compression tends to limit and control hemorrhage. The bowels ought not to be disturbed for several days. Only fluids, and those only in small quantities at a time, should be allowed, for two or three weeks at least. In cases of injured kidney, this is very important; for fluids tend to increase the activity of the kidneys, and in Hilton's case above alluded to, the patient at his own earnest request was allowed a little solid food on the eighth day, from which time fresh hemorrhage occurred, and the case went rapidly from bad to worse. In all abdominal injuries in which hemorrhage is to be feared, and as little intestinal activity as possible is wanted, solid food of every sort is to be forbidden; for it stimulates the action of the heart, and gives the muscular coats of the bowel more to do.

If peritonitis occurs, it must be dealt with as directed elsewhere; if abscess forms, it should be opened and drained. In renal injuries, if prolonged and exhausting suppuration of the kidney occurs, the question of nephrectomy should be well considered; and, indeed, if the indications of ruptured kidney or pelvis are marked, and the gravity of the case great, nephrectomy will in future be probably adopted, as giving the best prospect of recovery. If clots accumulate in the bladder, or are forced into the urethra, and there give rise to such pain and distress as was witnessed in Mr. Hilton's patient, median urethrotomy, or lateral cystotomy if requisite, should be performed; the bladder could then be washed out, and the clots discharged through the wound in the perineum. I well remember this proceeding being discussed in the case referred to, and feel sure that it would have saved much suffering had it been performed.

Mr. Rawdon¹, of Liverpool, has recently put this treatment to the test of practice, though, unfortunately, at too late a period in the course of the case. If the blood-clots are very small, they can be voided through the urethra, and do not set up vesical disease; or they escape easily, after washing out the bladder through a full-sized catheter. When of larger size, the patient ought not to be deprived of the relief of a median perineal incision of the urethra, which should be followed up by a lateral incision of the prostate, if more room for escape is requisite.

RUPTURE OF THE GALL-BLADDER AND THE BILIARY DUCTS.—Rupture of the gall-bladder, or of the cystic, hepatic, or common bile-ducts, or of the biliary canals within the substance of the liver, may occur as the result of either external violence, such as a blow on the abdomen, or excessive dilatation from sclerosis of their coats, compression by new growths, impaction of calculi, or other pathological processes leading to ulceration or sloughing of their walls. There is the authority of Rokitsansky for saying that the gall-bladder occasionally gives way by ulceration set up by gall-stones, and that death from peritonitis, due to extravasation of bile into the peritoneal cavity, is the result. Such a case, in which death followed three days after the rupture, is recorded in the London Pathological Society's Transactions,² and many others are to be found in pathological records.

¹ Lancet, May 26, 1883.

² Trans. Path. Soc. Lond., vol. xix. p. 259.

Mr. John Freeland¹ (Government Medical Officer Antigua, West Indies) records the case of a black woman, aged sixty-five, who for many years had been troubled with intermittent fever, followed by a regular train of symptoms commencing with vomiting, colicky pains, and tenderness of the abdomen, and ending with jaundice, more or less severe. In one attack, in addition to the above symptoms, she was seized with excruciating pain in the stomach and chest, inability to retain anything swallowed, hot and dry skin, hurried pulse, tender abdomen, and death from collapse in about five days—after increased abdominal pain, tenderness and vomiting, and rapidity and failure of pulse. At the autopsy, the abdomen was found literally filled with blood and bile; the intestines were gangrenous in spots; the peritoneum everywhere inflamed, and with adhesions; the liver and gall-bladder healthy, the latter empty and smaller than normal; the spleen stained indelibly throughout with bile; the hepatic duct recently ruptured; the calibre of the duct much smaller, and its length greater than usual. In some places the duct was pouched, and the pouches contained gall-stones of size varying from that of a pea to that of a strawberry. In one of these pouches was a large slit, with firm edges, and completely plugged by the accurately-fitting end of a biliary calculus, which by pressure had caused the ulceration. The second or recent rupture was the cause of death; the older one had existed for years, and had always been occupied and closed by the gall-stone, except occasionally when some exertion displaced it temporarily and allowed the bile to escape. These occasional extravasations led to the intermittent attacks; the final and most severe one was set up by the recent rupture.

Rupture of the smaller biliary canals, followed by extravasation of bile into the liver, repeatedly occurs in cases of retention of bile; and extravasation of bile from the same canals follows laceration of the liver, whether the peritoneal coat be torn or not; but the significance of the extravasation of bile in these cases is submerged in that of the general injury of the liver. Rupture of the gall-bladder, or of the biliary ducts beyond the liver-substance, is apt to be followed by speedy death from peritonitis, owing to the escape of large quantities of bile into the cavity of the peritoneum. From experiments on animals, as well as from what is occasionally seen after accident or operation in man, the fatal termination is probably brought about, not so much by the sudden escape of bile into the peritoneum, as by the continual pouring out of fresh quantities into the peritoneal sac. There are a few cases on record which prove that, if the continued escape of bile into the general cavity of the peritoneum be prevented, recovery from rupture of the gall-bladder or of a large bile-duct may take place. Provided that the effusion of bile is at first slow, so that there is time for adhesions to form a cyst-like chamber, shut off from the general peritoneal cavity, large quantities, even two or three gallons, of bilious fluid may accumulate outside the biliary passages and form a large tumor in the right hypochondrium, pushing up the diaphragm and lung, and causing a prominence of the anterior abdominal parietes, over the region of the liver. Such was the condition in Skeete's,² Fryer's,³ and Barlow's⁴ cases, the latter two of which ended in recovery. In each of these cases repeated tapplings, at intervals of about ten days, led to the withdrawal of as many as six or seven quarts of fluid. The fluid removed in Mr. Barlow's case was examined by Dr. Owen Rees and Mr. Thomas Taylor, and was found to be "full of bile." Dr. Rees estimated that it contained eight-tenths of bile and two-tenths of foreign matter. For a time after the accident, the feces in Fryer's and Barlow's cases were white, but as soon as bile began again to pass by the bowel the cysts ceased to refill, and the patients returned to a state of perfect health.

¹ *Lancet*, May 6, 1882, p. 731.

² *London Medical Journal*, vol. vi. p. 274. 1785.

³ A Case of Extravasation of Bile into the Cavity of the Abdomen. *Med.-Chir. Transactions*, vol. iv. p. 330.

⁴ *Ibid.*, vol. xxvii. p. 378.

There is little room to doubt that in these cases either the gall-bladder or one of the biliary ducts was ruptured, that for a time all the bile secreted was poured into a cavity formed by inflammatory adhesions, and that ultimately the proper channel became re-established. This favorable termination seems to me to be explained by the light of Sir Benjamin Brodie's experiments on ligature of the ductus choledochus. He found that the pressure of the ligature on the bile-duct was unlike in its effects to that on an artery or vein; that it did not cause adhesion of the apposed surfaces; but that a mass of organizable lymph was effused, and adhered to the duct above and below the seat of ligature, as well as to the surrounding parts. Thus a cavity was formed in which lay loosely the ligature which had been detached by ulceration of the duct. Into this cavity the bile could be made to flow from the orifice above, and out of it by the orifice below the point of ulceration, so that, though the continuity of the biliary duct was destroyed, a good bile-passage was restored. Sir Benjamin Brodie remarks that the same thing happened when two ligatures had been applied at some distance from each other on the common duct. Tiedemann and Gmelin obtained similar results on dogs; in their experiments the bile-passage was re-established in a period varying from thirteen to twenty-six days after the ligature was applied.

The gall-bladder may be completely torn away from all its connections, without immediate death being caused, and without the escape of its contents:—

Dr. Francis Ogston,¹ of Aberdeen, has recorded the case of a man whose belly was forcibly knelt upon. The gall-bladder was found, full of bile, lying loosely in the abdomen near the umbilicus, in front of the small intestines, having been broken away from the cystic duct close to its origin. A thin piece of the liver, one inch in breadth and corresponding to the cystic hollow, was firmly adherent to the surface of the gall-bladder. The patient died on the third day after the accident, from hemorrhage, ten pounds of blood being in the peritoneal cavity. Ogston records a second case, in which the gall-bladder was torn away with part of the liver, in a very similar manner; but in this instance the injured viscera protruded through a wound in the abdominal parietes, and death was instantaneous.

In Dr. Walter Fergus's² well-known case, the gall-bladder was ruptured above, opposite the junction of the hepatic with the cystic duct, and the liver was also lacerated; yet the patient was so well on the fifth day after the accident that he was considered convalescent, and allowed to get up; two days subsequently he was suddenly seized with the symptoms of acute peritonitis, and died on the ninth day. At the autopsy, the gall-bladder was found empty, the peritoneal cavity contained a large quantity of bile, and peritonitis was general. The wound in the liver was undergoing repair, and it is possible that, had absolute rest been enjoined for a longer period, extravasation of bile might have been prevented by adhesions, and recovery might have ensued.

The commonest seat of rupture of the bile-organs would seem to be some part of the cystic duct. Poland³ and Wolff⁴ have recorded cases of rupture of the common bile-duct, and M. Campaignac⁵ a case of longitudinal rupture of the left branch of the hepatic duct; while Bryant gives, on the authority of Dr. Sutton, of the London Hospital, a case of transverse rupture of the hepatic duct, one-quarter inch above its junction with the cystic duct. When the gall-bladder is filled with gall-stones, a blow over it is very prone to cause its rupture. Hoffman relates the case of a farmer's wife who was killed by a blow from her husband in the left hypochondrium. The gall-bladder was filled with calculi and freely torn. He also cites another similar case of a woman who was killed by a blow from a stick. Dr. Maclachan⁶ gives the

¹ Brit. and For. Med.-Chir. Review, vol. xxxix. p. 193.

² Med.-Chir. Trans., vol. xxxi. p. 47.

³ Fothergillian Prize Essay.

⁵ Journal Hebdom., t. ii. p. 210. 1829.

⁴ Gaz. Méd., 1830.

⁶ Med. Gaz., vol. xxxvii. p. 968.

case of an old man who fell on the floor in getting out of bed, and died in forty-eight hours from peritonitis. The gall-bladder was ruptured, and a large stone was found impacted in the cystic duct.

The *symptoms* of rupture of these organs, if uncomplicated by injury to other viscera, depend on whether the extravasation takes place into the peritoneal cavity, or into a space surrounded by adhesions. If no extravasation occurs, the only symptoms may be more or less collapse, with some abdominal pain, vomiting, and dyspnoea; and these may soon pass off. If the bile escapes into the general peritoneal cavity, the symptoms of acute peritonitis will set in. John Bell says, "I saw a man die in a very miserable condition, who had, by a fall, torn the gall-ducts, so that the abdomen swelled with dreadful pain; the most thorough jaundice I ever saw; and the abdomen, when opened, was full of bile, serum, and coagulated lymph, the intestines universally tinged of a yellow color, universally inflamed, adhering at some points and gangrened in others."¹ If the bile escape into a space circumscribed by adhesions, there will be the symptoms of acute, localized peritonitis, and jaundice; at a later period a tumor will be formed in the hypochondrium, as in the cases above referred to; and if the whole of the bile be extravasated into this cyst-like space, the stools will be white. The time at which the bile escapes varies: in Dr. Fergus's case this occurred on the seventh day; in Ogston's, in fifteen hours; whilst in others it was at the moment of the accident. If the gall-bladder itself gives way, the bile is generally poured out in large quantity, and death follows immediately. Leseure² mentions five cases, in four of which death was instant; the fifth case was that of a child, aged twelve years, who lived till the fourth day. In Sutton's case of rupture of the hepatic duct, the abdominal pain appears to have slowly increased from the time of injury; jaundice and great abdominal distension supervened after some days, and death occurred on the thirty-eighth day. Jaundice is, probably, the effect of shock, though it may be the result of obstruction at the seat of injury.

Treatment.—In any case where there is reason to suspect that the gall-bladder is injured, or the bile-ducts torn, the greatest quietude should be observed, so as to prevent, if possible, the extravasation of bile, and to give time for the surrounding of the wounded part by organizable lymph. The cases quoted prove that the bile is not always poured out at once; and if straining by vomiting, the use of purgatives, and active movements of every part and organ of the body be avoided for a few weeks, there will be plausible grounds for hoping that recovery may take place. Absolute rest in bed, warm fomentations to allay pain, and the application of leeches over the seat of injury, should be resorted to; a little ice may be sucked from time to time to check sickness and allay thirst; and as little food as possible, and that only of a liquid nature, should be given. If after several days it should become necessary to relieve the bowels, enemata, not purgatives, should be employed. If a tumor forms, the extravasated bile should be evacuated as often as need be by the trocar and canula. Fryer's and Barlow's cases show that success sometimes attends this practice. Laparotomy, followed up by suture or removal of the gall-bladder, ought, in certain cases, to be adopted.

RUPTURE OF THE THORACIC DUCT.—Next to nothing is known of this occurrence, either as a distinct injury or as a complication of other abdominal ruptures. It is difficult to suppose that such an accident as simple

¹ Discourses on the Nature and Cure of Wounds, 3d ed., p. 358.

² Sur les Ruptures et les Perforations de la Vesicule Biliaire. Paris, 1824. (An inaugural dissertation.)

traumatic rupture of the thoracic duct without an external wound could occur; but if it happened, and life were prolonged for any number of days afterwards, the physiological purposes of the duct suggest what the symptoms would be, viz., those of inanition, owing to the whole or greater part of the blood-forming fluid derived from the digestion of food being perverted from its natural channel. One would not expect that the extravasation of lymph would be quickly fatal, but it is conjectural how far surgical relief could be afforded, even if the extravasated fluid should become encysted, either behind or within the peritoneal cavity. Rupture after dilatation of the thoracic duct by the pressure of some extrinsic growth, or from some intrinsic cause such as chalky or cheesy concretions in the duct, is a recognized contingency.

RUPTURE OF THE PERITONEUM.—The parietal peritoneum, the peritoneum covering the mesentery or omentum, or the visceral peritoneum of any of the solid or hollow organs, may be ruptured without injury to the muscles of the parietes or to the abdominal viscera. Such an accident is rare as the result of a blow or other form of external violence, but it is not so very infrequent in the case of the peritoneum covering the uterus, or as a result of over-distension of the stomach or intestine. The two chief dangers of rupture of either parietal or visceral layers of the peritoneum are peritonitis and hemorrhage. The symptoms, treatment, and results of contusions of the abdomen followed by intra-peritoneal hemorrhage, have been already described. We now pass to the consideration of traumatic peritonitis.

TRAUMATIC PERITONITIS.

Causes.—Inflammation of the peritoneum is caused by injury either from without or from within the abdomen. From without, the causes are contusions, ruptures, and wounds of the abdominal parietes. From within, peritonitis may be started by the giving way of hydatid, ovarian, or other cysts, by perforation from disease of the hollow viscera, or by the bursting of an intra-abdominal abscess; the penetration of the gut by intestinal worms has also been known as the origin of fatal peritonitis.

Though all these causes are in a sense traumatic, the name Traumatic Peritonitis is generally applied only to inflammation started by some blow or other external violence, and then, whether the abdominal parietes are injured or not, and whether the peritonitis arises directly from the injury, or by extension of inflammation from some other structure of the abdominal parietes or contents to the peritoneum. Though our experience of to-day has proved the peritoneum to be tolerant of an amount of interference which not many years back would have been regarded as quite incredible, still it is even now equally true that very slight wounds of the peritoneum may lead to peritonitis, if foreign bodies or septic materials be introduced from without, or escape from the viscera within, or if the persons upon whom such wounds are inflicted be in an unhealthy condition. In such cases, however, though the wound is the exciting cause, it is these associated phenomena, and not the wound itself, which are most conducive to the peritonitis.

Varieties.—Traumatic peritonitis is always more or less acute, and may be either local or general. Although it is apt to spread rapidly over the greater part or the whole of the membrane, it is not unfrequently limited to the immediate neighborhood of the injury. Commonly the form of inflammation is the sthenic; but if it occurs in a feeble, unhealthy subject, it is likely to assume the asthenic or puriform character. If due to the intro-

duction of poisonous or decomposing material, the peritonitis will certainly take a septic form.

Symptoms.— These usually show themselves in from six to thirty-six hours after the injury, and then develop very rapidly. In some cases of injury, and especially after the rupture of any of the abdominal organs, the onset of the symptoms is immediate, or nearly so. In other cases some days may elapse between the receipt of the injury and the first indication of peritonitis. The invasion of the inflammation may be masked or retarded by the collapse following the injury, but as soon as reaction has set in, the local and general symptoms become thoroughly pronounced.

Of the local symptoms pain is the earliest, and the most striking and severe. It is sometimes excruciating and unbearable, and may be preceded by a rigor. Commencing at the seat of injury, it may spread over a larger and larger area, until perhaps it pervades the whole abdomen. Pressure, movement of every kind, the acts of vomiting, defecation, and micturition, intensify it. In order to lessen the pain as much as possible, abdominal respiration ceases, and tension on the abdominal walls is sought to be relieved by posture; hence the patient lies on his back with the thighs and knees flexed, and sometimes the hands and arms are used to protect the belly from the weight of the bedclothes. The pain is variously described as hot, burning, stabbing, or cutting; and from time to time it is increased by paroxysms of greater intensity, due to the vermicular or spasmodic contraction of the intestines. In exceptional cases the pain is but moderate, and it may be absent altogether.

Vomiting is an early and a troublesome symptom, and occurs both spontaneously and as an effect of taking anything by the mouth. At first the vomited matter consists of the contents of the stomach and upper part of the intestine, then it becomes of a greenish or dirty brown and watery character, very bitter to the taste; and at a later stage it is occasionally feculent. Eructations and hiccough are not uncommon, and are sometimes distressing; constipation and gaseous distension of the bowels, owing to the palsied, softened, and oedematous state of the intestinal coats, is the general rule. With the tympanites are sometimes associated feeble peristaltic movements; and rumbling or gurgling sounds, or borborygmi, may be heard. The abdominal distension varies, both in degree and in rate of increase, being most marked, as a rule, in persons with feeble or lax abdominal parietes. Before the distension occurs, the muscles of the abdominal walls are retracted, hard, and rigidly contracted, and even after they become paralyzed, the abdominal walls are still very tense, owing to the rapid increase in the distension of the stomach and intestines. The urine is high colored and loaded with urates, is passed very frequently, and causes scalding. At a later stage, retention supervenes from palsy of the muscular coats of the bladder. The respiration is quick, shallow, and entirely thoracic, not diaphragmatic nor abdominal. The irritation of the vaso-motor nerves is excessive, owing to the large area over which they are frequently involved in this disease; and this irritation produces a great effect upon the heart. The pulse is small, reaching 120–160, wiry, non-dicrotic, or very slightly dicrotic; and the arteries, even the very small ones, are contracted. The heart is not, however, stimulated thereby to strong, slow contractions, in order to overcome this resistance to the free flow in the vessels, but beats slowly and feebly. Except as regards rapidity of pulse, the state of the circulation differs widely from that which is usual in fever.¹ The pulse has usually a good pressure, but it may after a time

¹ See Galabin, On the State of the Circulation in Acute Diseases. Guy's Hosp. Rep., 3d series, vol. xix.

become compressible, and yet, owing to the feebleness of the heart's action rather than to high arterial tension, it will remain non-dicrotic. A dicrotic pulse in peritonitis indicates some complication in the disease. The feeble state of the heart, and the cough, hiccough, and shallow respirations, are also largely due to the direct effect of the tension on the diaphragm and thoracic viscera by the great gaseous accumulation within the abdomen. Intestinal movements are seen through the tense abdominal walls; to the hand, the abdomen is smooth and regular, and though in the earlier stages the muscles contract on palpation, at a later stage the belly feels simply drumlike, and the normal hepatic and splenic dulness is completely lost. The amount of fever, as indicated by the temperature chart, varies greatly. As a rule, the temperature rises rapidly in the early stage, and continues high for a day or two; it has, however, no regular course, and remissions are not infrequent. In the asthenic form of acute peritonitis, the temperature may not rise at all, or may be even below normal. Indeed, in many cases after operation for hernia or ovariectomy, and in general blood-poisoning, all the symptoms of peritonitis are masked. Patients rapidly sink and die from peritonitis under such circumstances without complaining of abdominal pain, or evincing any of the characteristic local symptoms of the disease, except steadily increasing tympanites. In such cases, it is the increasing rate and diminishing volume of the pulse, the pinched features, restlessness, and cold, clammy skin, which warn the surgeon of the fate which has overtaken his patient.

The appetite in traumatic peritonitis is lost, thirst is intense, the tongue is furred at the sides, and red, or brown, or dry at the centre, and a sensation of heat at the epigastrium is often complained of. The patient becomes very uneasy and restless, and whilst keeping the trunk steady, tosses the arms and hands incessantly outside the bedclothes. The hands and feet are hot and burning, so that the patient begs to have them frequently moistened, and will hold in each hand a cold, damp cloth, which he often desires to have wetted. The countenance soon becomes expressive of pain and anxiety; the features look sunken, pinched, and withered; dark areolæ surround the orbits, and there is extreme prostration of strength, though the intellect remains clear, and delirium is rare. Occasionally, more especially if the intensity of the inflammation spends itself in the neighborhood of the liver and bile-apparatus, jaundice occurs. In exceptional instances, a considerable amount of ascites exists, and fluctuation is present. Rarely, delirium is a prominent and early symptom. High fever, the passage of bloody stools or blood-stained vomit, incessant hiccough, diarrhœa, albuminuria, and very urgent dyspnœa from extreme tympanites, are also occasionally witnessed.

Diagnosis.—This is usually easy, but some painful conditions of the abdominal wall following an injury may be mistaken for traumatic peritonitis. Thus cutaneous hyperæsthesia, localized inflammation, or even rheumatic affections of the muscular and aponeurotic structures of the parietes have led to error, especially when occurring in nervous or hysterical subjects, and when abdominal distension, sickness, and constipation have been associated with the local symptoms. With proper care, however, such conditions will readily be distinguished from peritonitis. Localized inflammation, commencing as the result of an injury in the areolar tissue of the pelvis or loins, or around the kidney, cæcum, or bladder, may lead to the suspicion of peritonitis; but such diseases are prone to involve the peritoneum, and it cannot be positively asserted, under the circumstances, that this membrane is not inflamed; and the peritonitis once started tends rapidly to become general. Cramp in the stomach, intestinal colic, and other painful abdominal affections, if accompanied by vomiting, rapid pulse, and a tendency to collapse,

might be mistaken for peritonitis, though the history, mode of onset, and relief of pain by pressure, ought to clear up any doubts.

Prognosis.—The more localized the peritonitis, the more hopeful the result; the more rapid the symptoms, the graver the case. When the peritonitis is the result of direct injury limited to the peritoneum or parietes, the prognosis is more favorable than when it arises under other circumstances. When due to rupture or perforation of the viscera, or excited by septic poison, death is almost certain. In most cases the fatal termination occurs within a week or ten days, or less. Sometimes death takes place during the height of the attendant fever; but more frequently the mode of death is by asthenia, the respiration and heart's action becoming more and more feeble, until fatal collapse supervenes. Pain and even tympanites then become less marked; the temperature falls below normal; the extremities feel cold and turn blue; the skin is clammy and unnatural to the touch; the pulse flickering, irregular, and too fast to count; the respiration is hurried, jerky, and sighing; the voice weak and whispering; and the expression one of helpless and imploring anxiety. Sometimes before, at, or immediately after death, a quantity of dark coloured fluid flows freely through the mouth and nose.

Occasionally the acute symptoms of traumatic peritonitis subside, but leave the patient ill, with an abnormal temperature, great debility, and some localized collection of inflammatory fluid; this, after a variable time of further suffering, may burst, and, forming a communication with some hollow organ, recovery may afterwards ensue, or, on the other hand, death may occur from pyæmia, septicæmia, or exhaustion. In mild cases of traumatic peritonitis, or if the inflammation be limited in extent, or the inflammatory products fibrinous or sero-fibrinous, or if the patient be young and of vigorous constitution, and judicious treatment have been adopted at an early period, recovery may take place; but death may occur at any period after recovery from acute peritonitis, from the effects of adhesions or bands, the products of the inflammation. Constipation and complete intestinal obstruction are common consequences of these inflammatory adhesions.

Treatment.—In the treatment of acute, traumatic, as well as of other forms of acute peritonitis, it seems superfluous to enjoin absolute rest of the abdominal muscles, and perfect freedom from weight and pressure upon them, because the feelings of the patient will secure attention to these points, and nature herself does much to compass them. The application of leeches to the abdomen, as soon as pain sets in, followed by hot fomentations frequently applied, is the best local treatment. As many as twenty to thirty leeches, or more, may be used, if the patient be of a robust and healthy constitution. Local bleeding is much to be preferred to venesection, in peritonitis; but it is only of service in the early stages of the disease, and is not to be employed at all in the asthenic forms, such as occur after operations for hernia, ovariectomy, and other abdominal operations. With the hot fomentations may be used the extract of conium, belladonna, or opium; or turpentine stupes may be employed; cold compresses, or flannels wrung out of ice-cold water have been advocated, instead of hot applications, and perhaps, in the early stage of acute peritonitis, a more extended trial will prove their worth; pain and nervous and intestinal irritability are said to be allayed by cold, and certainly the bloodvessels of the inflamed parts are contracted by it; but the sensations of the patient must in part guide the surgeon in the employment of cold as a remedy. In the later stages cold applications are out of the question, and hot should be used; at a still later period, blisters, iodine, or mercurial preparations are sometimes useful in promoting the absorption of inflammatory products.

The best internal remedy is opium, given in half or one grain doses every

three or four hours: it allays pain, diminishes reflex irritation, and quiets the action of the stomach and intestines. It may be administered by the mouth or rectum; or morphia may be subcutaneously injected instead. In children, and in persons afflicted with renal disease, opium and morphia must, however, be employed with great care. In young subjects, and when the peritonitis is of the sthenic form, calomel, in one grain doses, combined with opium, and given until the system is brought under its influence, is often of great benefit; in some cases it will be found to afford great relief from meteorism. Nausea and vomiting are best combated by sucking small pieces of ice, or by taking small quantities of iced, effervescing drinks, with hydrocyanic acid in small doses. Sometimes the subcutaneous injection of morphia has the effect of checking sickness. Constipation should be left without treatment for some days, and then enemata are the best aperients. For the first thirty-six or forty-eight hours, no food beyond a little iced milk need be given, then thick beef-tea or essence of meat, in teaspoonfuls at a time, at intervals of fifteen or twenty minutes should be taken. If the stomach rejects all food, an enema of two ounces of beef-tea, with half an egg, should be given every five or six hours. If there is great exhaustion or depression, wine or brandy should be allowed. After the first week a more liberal diet—still, however, to be taken in small quantities at short intervals—may be permitted. During the whole period of convalescence, much care is requisite in feeding, in securing regularity of the bowels, and in avoiding all undue action of the abdominal muscles.

In all cases, after any injury to the abdomen, absolute rest should be enforced: rest by position, and the mental and physical quietude to be obtained by opium, will often prevent the occurrence of peritonitis, and will limit and subdue it when once set in. The surgeon every now and again sees a case of severe local peritonitis which has been caused by, though it has commenced some days after, a hurt to which but little if any attention has been given; and it is fair to presume that the patient would have escaped the inflammation if he had but taken proper precautions for a few days after the reception of the injury.

WOUNDS OF THE ABDOMEN.

Wounds of the abdomen are usually classified as “non-penetrating,” that is, wounds of the parietes without perforation of the peritoneum; and “penetrating,” that is, wounds involving the cavity of the peritoneum. The non-penetrating wounds in certain regions of the abdomen, such as the lumbar and hypogastric, may be complicated by protruding or wounded viscera, without implication of the peritoneum. The surgeon not unfrequently designedly inflicts such wounds, as when he performs colotomy or nephrolithotomy, or simply explores the kidney; or, again, as when for the relief of retention of urine he perforates the distended bladder above the pubis. That these wounds are not very dangerous, may be learned from the large success which results from these operations.

Penetrating wounds may or may not be complicated with injury, protrusion, or both injury and protrusion, of the viscera; but whether they are so or not, they are as a class much more serious than non-penetrating wounds. And yet there is nothing necessarily dangerous in the simple wound of the peritoneum, as the numerous operations practised on the abdominal cavity, and the varied and successful extension of such operations, amply prove. They are the accompanying circumstances, such as shock, neglect of surgical treatment for some hours after the accident, the bruising and wounding of the

abdominal contents, and the escape of noxious fluids into the cavity of the peritoneum, which are the causes of danger in penetrating wounds.

Both the penetrating and the non-penetrating wounds vary according to the nature of the wounding body, and the mode of infliction of the injury. They may be either incised, punctured, lacerated, contused, or gunshot wounds. The incised are the simplest and most favorable; the punctured, if we except operation wounds, are the most common; the lacerated and contused are the most tedious in recovery, and the most prone to be followed by suppuration and sloughing; and gunshot wounds are the most fatal.

I. NON-PENETRATING WOUNDS OF THE ABDOMEN.

Wounds of the same class differ from one another according to their extent and depth; their direction, in relation to the course of muscular fibres, blood-vessels, and nerves, and the natural folds or lines of the surface; their situation, with respect to the varying thickness of the parietes; and their form, as to whether they are linear, irregular, jagged, angular, or flap-like.

INCISED WOUNDS are produced by knives, razors, scythes, hatchets, sabres, pieces of tin, glass, or any other sharp-edged or cutting bodies.

Symptoms.—They are always followed by more or less gaping of the divided tissues, the degree of which depends upon the elasticity of the tissues, upon the tension of the abdominal walls at the time of, or subsequent to, the injury, and upon whether the wound is transverse to, or parallel with, the fibres of the muscles. The amount of bleeding will depend upon the size and number of the vessels wounded, but usually it is not severe; the pain which follows, is due first of all to the division, injury, or exposure of the nerve-fibres, and afterwards to the pressure of inflammatory effusion. Superficial or tegumentary wounds are less severe in their symptoms and in the risk of complications, and their treatment is more simple than that of the deep or musculo-tegumentary. There is scarcely any bleeding, and little or no difficulty in maintaining the edges together, in the superficial wounds; but, owing to the great thickness of the integuments in the loins, and to the prominence of the ribs at the epigastrium, sutures are almost always requisite in those situations. Sutures are also, as a rule, beneficial, though not necessary, elsewhere. In the hypochondria and epigastrium, the mobility of the ribs may require restraining in order to prevent traction on the sutures. Where the integuments are very thick, a wound may extend for some depth without reaching the muscles. In deep wounds, much depends on the division of muscles. In the epigastric, umbilical, and hypogastric regions, a transverse wound gapes widely, and possibly hemorrhage is severe from branches of the internal mammary or deep epigastric arteries, or some of the larger veins here situated. In the hypochondria, if the intercostal spaces are penetrated, troublesome bleeding may occur from the intercostal vessels. In the loins, the erector spinæ and even the quadratus muscles, as well as the posterior parts of the flat muscles and the lumbar arteries and veins, and branches of the spinal nerves, may be divided. Poland has pointed out that, if the external oblique muscle is wounded parallel to its fibres, and the internal oblique and transversalis are also divided, there is a liability for the blood and other discharges to collect instead of escaping, owing to the closure of the incision in the external oblique. In the iliac region, longitudinal wounds gape more than the transverse; here, too, there is a probability of the spermatic cord or the deep epigastric artery being wounded.

Treatment.—In the treatment of incised wounds, it is necessary, here as

elsewhere, to restrain hemorrhage; to remove all dirt, pieces of clothing, or other foreign bodies; to provide for drainage; and to procure union of the divided edges.

(1) If the bleeding comes from some quite small vessels, or capillaries, and is of the character of oozing, exposure to the air for a short time will suffice; if from a vessel of larger size, such as the superficial circumflex iliac, or superficial epigastric, or a large muscular branch, a twist or two with pressure-forceps, or a ligature, will be required. If the hemorrhage be profuse or persistent, and its source a deep artery or vein, the wound must be enlarged, if requisite, to secure the bleeding ends. In bleeding from the deep epigastric, circumflex iliac, mammary, or lumbar arteries, there is danger in trusting to palliative measures. Many cases might be quoted to illustrate the fatal consequences of temporizing with compresses, binders, and styptics. The ligature, or torsion, is necessary, and in such cases the best anatomist will often prove the safest surgeon. Secondary hemorrhage is likely to occur from coughing, vomiting, or other form of straining, if the bleeding be only temporarily checked by coagulum. Compresses, graduated or otherwise, are not to be recommended: they cannot be well borne; they are often ineffectual, because there is no counter-resistance; and they are liable to cause burrowing of blood amongst the tissues, and in deep wounds to press away the peritoneum from the rest of the parietes.

(2) In the loin, in consequence of the great depth of the parietes, a foreign body may be lost from sight in the wound, and therefore not be detected; elsewhere there is not much chance of its escaping the scrutiny of a careful surgeon. Unless there be ground for suspecting the presence of an extraneous substance, probing should not be resorted to in abdominal wounds. The most scrupulous cleanliness must be observed in the dressings, and it is well to begin by washing the wound with some antiseptic solution.

(3) When there is blood in the wound, or a probability of oozing, a drainage-tube, or a twist of catgut, horse-hair, or oiled silk, should be inserted at one end of the incision.

(4) To bring the edges into apposition, and keep them there without tension, mobility, or irritation, it is well, in addition to sutures, to support the parts by long strips of adhesive plaster, well applied, so as to get a good hold of the tissues, and prevent them moving in respiration or in changes of position. Posture, too, is a great adjunct in securing the contact of the edges and keeping them at rest by relaxing the muscles. Thus, in transverse wounds in front of the abdomen, the trunk and thighs should be kept flexed; in transverse wounds of the lateral part of the belly, the trunk should be inclined towards the injured side; in wounds behind, and in longitudinal wounds elsewhere, the straight, recumbent posture should be kept. Whatever form of dressing be employed, it is always well to give support to the wounded part by applying it so that a gentle, elastic compression shall be exercised. This is easily done by placing a pad of cotton-wool beneath the retaining bandage.

There has existed a good deal of difference of opinion as to the use of sutures, but, with all deference for the teaching of Mr. Guthrie and others, it is my opinion that, though not always necessary in superficial wounds, they are advantageous in deeper ones. The interrupted suture is the best form; and the best materials are fishing-gut, catgut, or silk which has been properly prepared in a solution of melted white wax, carbolic acid, and chloroform. The sutures should be passed through all the divided tissues, muscle as well as fasciæ and skin, and should be inserted sufficiently wide of the cut edges to avoid their ulcerating or tearing through, before a bond of plastic material has been formed.

A restricted diet, gentle laxatives if the bowels are constipated, and opium if there be restlessness or pain, should be given.

In the majority of cases, incised wounds of the abdomen heal by primary adhesion if the above points of treatment have been attended to, and if the health, habits, and temperament of the individual are such as to favor quick and good repair. In other cases, healing takes place by the process of granulation in one of its various forms.¹

PUNCTURED WOUNDS are produced by spikes, nails, needles, daggers, bayonets, lancets, foils, swords, the horns of animals, splinters of wood, and other such like things. The wounds for the most part correspond in size and shape to the instruments by which they are inflicted; those that are caused by sharp weapons approach in character to incised wounds, whilst those that are caused by blunt instruments resemble contused wounds; in other words, sharp bodies perforate tissues by cutting, blunt ones by crushing or tearing. Punctured wounds are sometimes called "perforated," but in the case of the abdomen it must be remembered that they are not necessarily "penetrating" in the sense of perforating the peritoneum.

In punctured wounds, the tissues may be transfixed obliquely or at right angles; they are usually somewhat smaller than the inflicting body, but of the same general shape. They are but rarely followed by much, if any, bleeding; as a rule the vessels escape or are pushed aside, and, even if they are wounded, the blood is poured out into the subcutaneous or inter-muscular tissues, and ecchymosis appears at a longer or shorter time after the injury. If an artery be wounded, a false aneurism may form; if both an artery and vein, an arterio-venous or varicose aneurism may follow. If a nerve or one of its filaments be injured, there will be immediate pain; and unless it be completely divided, it may give rise to prolonged suffering over the whole area in which the nerve-trunk is distributed. At a later period, pain will be excited by the pressure of effused blood or of inflammatory fluids. If the wound be deep, severe consequences are likely to follow, such as traumatic peritonitis; inflammation or suppuration in the different layers of the abdominal walls, which frequently simulate, even when they do not cause, peritonitis; cutaneous or cellulo-cutaneous erysipelas; septicæmia, pyæmia, and death. Inflammation is a frequent consequence of punctured wounds, and will almost certainly follow when they have been inflicted by a rusty, dirty, or blunt instrument. It spends itself chiefly on the deeper structures, and is prone to run on into suppuration, the symptoms attending which are sometimes of a typhoid character, and then not rarely prove fatal. When inflammation occurs, the wound swells, becomes red, painful, throbbing, hard, and tender, and ceases to discharge if it has previously done so; the pulse and temperature rise; the abdomen swells, grows hard and tense; coughing and perhaps even quiet respiration is painful; rigors usher in suppuration; cold, hot, and sweating stages, like ague, may repeat themselves; vomiting follows, and hiccough, cold sweats, great restlessness and sickening exhaustion precede death. Except in the superficial tissues, where fluctuation can easily be made out, the presence of pus can only be surmised by the constitutional symptoms, and by local fulness, hardness, and tenderness. The pus may burrow amongst the muscles widely, and when suppuration occurs behind the rectus, it may spread from xiphoid to pubis, without pointing or giving a distinct sense of fluctuation. Sometimes the matter points a long distance from the wound, as in the case of a soldier who, as related by Petit,² was wounded by a sword

¹ See Article on Wounds, Vol. II. pp. 18, 19, *supra*.

² Quoted by Guthrie.

a little below the xiphoid cartilage; fluid pointed after several days, and was let out through an incision, one inch above the right abdominal ring. In other cases the matter spontaneously discharges itself through the original wound. In mild cases the inflammation or suppuration may be limited to the immediate area of the wound, the constitutional symptoms being proportionately less severe; and convalescence sets in as soon as a free opening allows of the escape of matter.

Treatment.—The treatment is the same as for incised wounds. If hemorrhage is severe, or if there is reason to think from syncope or increasing tension of the tissues that free, deep-seated bleeding is going on, the punctured wound must be converted into an incised one, and the wounded vessel tied or twisted. The application of ice-cold dressings—or in old and enfeebled persons of warm fomentations—with opium to allay pain and induce physical and mental quietness, are the early remedies required. If inflammation occurs, relaxation of the muscles by position, absolute rest, leeches in large numbers—from fifteen to thirty—and large, hot, anodyne fomentations, must be employed. The use of a simple milk diet, attention to the bowels—but not the administration of severe purgatives—and the employment of narcotics, constitute the rest of the treatment. As soon as matter has formed it should be let out. Tonics, stimulants, and fresh air, are requisite after suppuration is thoroughly established.

LACERATED WOUNDS are occasioned by hooks, nails, or any form of tearing, such as is caused by machinery and railway accidents, or by falls from carriages or horseback, the person being dragged along whilst the abdomen is forcibly squeezed against or mutilated by some resisting substance.

Symptoms.—These wounds are usually followed by considerable suppuration of their edges, and if large flaps or strips of integument are torn or ripped up, there is often much difficulty in bringing them nicely into contact. There is usually not much hemorrhage at the time, but secondary bleeding may occur as soon as the shock of the accident has passed, or when reaction is established. Pain is often severe, but like hemorrhage is uncertain in its existence and degree. These wounds never heal by first intention. Like punctured wounds, they are prone to be followed by inflammation and suppuration; sloughing too is very apt to follow. Occasionally all the layers of the abdominal parietes are torn up, leaving the peritoneum perfectly intact. Poland, in his Fothergillian Prize Essay, has recorded the following case:—

A healthy and temperate baker, aged 38, was admitted into Guy's Hospital, having been violently dragged between the projecting ledge of a butcher's shop and his cart. All the layers of the abdominal muscles were torn up in a line from the spinous process of the right ilium to the symphysis pubis, laying bare a large surface of the peritoneum, and exposing the front surface of the bladder. The peritoneum was not wounded, but the intestines were projecting it outwards. The spermatic cord had escaped injury. There had been much hemorrhage, and he was collapsed. The urine was drawn off untinged with blood. The wound was cleansed, the ragged muscles arranged as well as possible, and the edges brought together with sutures; and the thighs and shoulders were raised. Stimulants were given and warmth applied. He soon rallied from the collapse, and his pulse improved. In the night he was bled to ten ounces, and calomel and opium were ordered. On the following day the abdomen was very tender on pressure, especially on the uninjured side, but there was no tension. Leeches were applied and castor-oil injection given, which producing no effect, a full dose of castor oil was administered, and also an injection of salts and senna before the bowels were freely opened. Some of the sutures were removed, and an offensive, thin, sanious serum mixed with bubbles of air was evacuated. The abdomen was fomented, and warm water dressing applied over the wound, the cutaneous edges of which were kept in apposition by plaster. After going on well for five days his strength began to fail and his

stomach to reject everything. The wound discharged immensely, and sloughs slowly separated; and he had profuse sweats. His breathing became fast and difficult, as if the injury to the abdominal walls would not allow the descent of the diaphragm. He died from exhaustion on the tenth day. Post-mortem examination showed very little evidence of peritonitis; but the whole surface of the wound was somewhat sloughy, though inclining to take on a healthy action. Pneumonia at the back part of both lungs.

Treatment.—The general indications for treatment are such as have been described in speaking of the other forms of wound. In the lacerated wounds special care must be taken to cleanse the tissues, and to remove foreign matter with as little disturbance to the parts as possible. Pain must be relieved by opium and sedative applications to the wound. Whilst the bowels must be opened, if the patient is suffering from the effects of constipation, it is most disadvantageous to be stimulating them with aperients and injections, especially when the wound is deep and the peritoneum exposed. Here, as in all forms of abdominal injury, quietude should be obtained and the intestines kept at rest, as far as possible.

CONTUSED WOUNDS are caused by instruments which bruise as well as divide the tissues; any form of wound may be contused. Thus an incised wound may be attended by contusion, as in the case of those made by the teeth of a saw; punctured wounds are contused if inflicted with blunt weapons, as by such as increase suddenly in diameter from point to handle, whereby the tissues are forced asunder as by a wedge; lacerated wounds are always more or less contused. Perhaps the usual forms of contused wound of the abdomen are those caused by spent balls, by fragments of shell, or by some heavy body passing over it. The area of contusion generally spreads wider and deeper than the area of laceration. Some of the most severe contusions are, moreover, entirely subcutaneous; the muscles, vessels, nerves, and fasciæ may be torn without any breach of the skin.

As in lacerated wounds, so in the contused, primary hemorrhage is slight; there is, however, danger of secondary hemorrhage; sloughing and ulceration are more likely to occur than in any other kind of wound, and indeed in many cases must occur before repair can commence. Contused wounds of the abdominal parietes, if deep, are therefore necessarily dangerous; and, in punctured wounds it is the contusion of their edges, together with the difficulty there is in draining away their discharges, which gives to many of them their especial risks.

Treatment.—As contused wounds cannot heal by first intention, there is no object in suturing their edges with precision. Sutures in these, as in lacerated wounds, must be used simply with a view of preventing unnecessary gaping. After cleansing the wound and stopping bleeding, the next step is to retain the tissues in place, cover them with some antiseptic dressing, and keep up their vitality by using a thick layer of absorbent cotton-wool as a medium for warmth. As soon as sloughing has commenced, special care must be taken to prevent putrefaction. Drainage should be thorough, and to this end it will often be well to make counter-openings for the insertion of drainage-tubes. Secondary hemorrhage must be treated by tying the bleeding vessels, or by the application of styptic wool, styptic colloid, or Ruspini styptic applied on cotton-wool or lint; there is in these astringents an additional advantage, as they assist in purifying and keeping the wound sweet. To hasten the removal of sloughs, carrot or charcoal poultices, or carbolic and lead lotions combined, applied as hot fomentations, are the best remedies. Whilst paying every attention to cleanliness, it must be remembered that the wound should be kept as quiet as possible; for this purpose an easy

posture, the gentle support of bandages, and, if necessary, the internal and local use of anodynes, are to be recommended. Tonics and stimulants will generally be required, and especially if the sloughing is extensive or the suppuration profuse.

GUNSHOT WOUNDS are of the nature of contused and lacerated wounds, the contusion being severe and extending to the surrounding tissues, as well as along the track of the missile. Hence it is that, in these cases, death often results from peritonitis, or from shock. Shock is occasionally very intense, even when the wound is comparatively superficial.

Symptoms.—Gunshot wounds generally present a blackish coloration at the edges of the aperture of entrance, and the surrounding parts are red or purple at first, and yellowish-brown or violet after a day or two. They differ widely according to the form and size of the projectile, its degree of velocity, and its direction. It is probably due to the smaller size and less velocity of the bullets used in civil life, that the consequences of gunshot, parietal wounds of the abdomen are not as severe in civil as in military practice. Even in warfare, non-penetrating wounds are attended with a low mortality, whilst in civil practice recovery is the rule. Setting aside the risks of peritonitis, the immediate consequences of shock, and the complications which arise out of wounds of the kidney, colon, or bladder, etc., a favorable prognosis may be given with fair certainty. Hemorrhage is not common in gunshot wounds, though severe primary bleeding may occur if the kidney or some large parietal vessel, such as the deep epigastric, has been wounded; and though secondary hemorrhage should be expected between the seventh and twelfth days, when the sloughs separate if an artery or vein has been contused. It must always be borne in mind that abscess and diffuse suppuration are likely to arise in the track of a bullet. A fistulous opening, attended with swelling and pain, and giving rise from time to time to profuse discharge, may ensue; pieces of clothing and of fractured bones may be discharged or removed. The numbness which is felt at first after a gunshot wound, is frequently succeeded in a few days by intense pain. When a ball, instead of traversing the tissues directly, becomes deflected by the edge of a rib, the xiphoid cartilage, or a layer of fascia, it may emerge at the opposite side of the trunk, and give the appearance of having passed straight through its cavity; thus a bullet, penetrating the skin at the scrobiculus cordis, has been known to traverse the cellular tissue beneath the skin, and make its way out again at a spot diametrically opposite to the wound of entrance; or, after deviating thus in its course, it may just fail to make its exit. I have had to remove from beneath the skin, close to the spinous process of the tenth dorsal vertebra, a pistol-bullet, which had entered the abdominal parietes opposite the anterior extremity of the tenth rib; the bullet had travelled around in the substance of the parietes. A ball may scoop or gutter out a portion of the integument without lodging or penetrating.

Diagnosis.—A certainty as to whether the abdominal cavity has been penetrated or not, cannot be arrived at from the apparent direction or course of the shot, neither is shock or functional derangement of the viscera sufficient evidence of penetration. Indeed, nothing short of actual ocular or digital demonstration of the peritoneum, the protrusion of viscera, or the escape of their contents, can be received as actual proof that the wound is a "penetrating" one. The peritoneum may be exposed or bruised, or separated from its parietal connections, without being penetrated; and the kidney, colon, bladder, or other extra-peritoneal organ, may be wounded without the peritoneal cavity being opened, and without extravasation into that cavity occurring. Such complications, however, greatly increase the dangers of gunshot

wounds of the parietes. Guthrie relates a case in which a musket-ball made a wound about four inches in length above the crest of the left ilium, and cut away the abdominal muscles so deeply as to expose the peritoneum. Ulceration of the serous layer was feared at the time of the separation of the sloughs, but, instead, granulations sprang up from the sides and bottom of the wound, which gradually healed without trouble. Guthrie adds that he had seen the same thing occur many times; so that he had no doubt of the great power possessed by the peritoneum in resisting ulcerative action going on in its immediate neighborhood.

Treatment.—The depression and general collapse which follow gunshot wounds of the parietes, will often require the cautious but liberal use of stimulants, and warmth to the extremities and spine. The next step is to remove the missile, or any extraneous substance which may have been carried in before it. The clothes should always be examined; it sometimes happens that a fold of a shirt or flannel is carried into the wound in front of the ball, without being torn, and that the ball is removed in the process of taking off the clothes. A nearly spent ball may enter the parietes a short distance, and then fall out by its own weight. Sometimes, though nothing is felt for a time, the ball by a lucky change of position presents itself at the wound, and can then be removed; or, failing this, it may gradually work itself out if its escape is favored by posture. If it appear that the ball has lodged in the tissues, search should be made by digital examination, not only of the trunk but of the limbs also, especially along the direction in which it is probable, from the account given, that the missile has traversed. Thus, a ball may take an upward or downward course in the sheath of the rectus muscle; or may skirt along Poupart's ligament and the iliac crest, outside the peritoneum, and thus reach the liver; or, following the course of a rib, may be found at the opposite end of the bone; or may pass downwards to the buttock or thigh, or upwards to the shoulder or axilla, or may sink into the pelvis and be subsequently cut out in the perineum. Digital examination and probing should be conducted with extreme care, owing to the risk of forcing an opening, in this way, into the peritoneal cavity. If there be no indication of its whereabouts, the ball must be left to become encysted, though, instead of becoming encysted, it may shift, and subsequently be detected. Hennen relates a case in which a piece of shell, nine and a half ounces in weight, and of an irregular and quadrilateral form, was detected three weeks after the injury, and felt by the patient to change its place to a certain degree according to the position of his body; yet previously there had been no indication of its presence. It was removed from the right lumbar region, through an incision four inches long and half an inch deep, and the patient recovered.

Should a ball be found beneath the skin, it should be removed with as little disturbance as possible, through an incision made down upon it. Immediately after the removal of the ball it will be well to send a gentle current of some antiseptic fluid (Condy's fluid or carbolic-acid lotion) along the track. In this way I have washed out small pieces of clothing, which would have given rise to irritation and discharge, if not to abscess, had they been left. After inflammatory swelling has once begun, it is not likely that such foreign substances will escape until after the establishment of free suppuration. During the period of inflammation, leeches and warm fomentations, with salines, refrigerants, and opium, are requisite. Sloughs must be removed; and collections of unabsorbed blood or of pus should be freely laid open, to prevent the extension of inflammation to the peritoneum. Absolute quietude of the trunk and of the abdominal viscera are important points in the treatment. If the kidney be wounded, provision must be made for the

free escape of urine and pus; if very badly wounded, or if hemorrhage from it be persistent and alarming, or if it be prolapsed, lumbar nephrectomy should be performed.

II. PENETRATING WOUNDS OF THE ABDOMEN.

Penetrating wounds of the abdomen may be divided into: (1) simple wounds; (2) wounds with protrusion of, but without injury to, the abdominal contents; (3) wounds with protrusion and injury; and (4) wounds without protrusion of, but with injury to, the viscera. It has been already stated that these wounds, like the non-penetrating, may be either incised, punctured, lacerated, contused, or gunshot; but after the foregoing description of non-penetrating wounds, it is unnecessary to describe the penetrating under these headings. The relations of the wound to the viscera and to the peritoneum, give the leading characters to penetrating wounds.

In judging of wounds of the abdomen, we are likely to be deceived by the appearance of the patient, as well as of the wound. He may be conscious, comfortable, and calm, though the subject of a most severe and critical wound; or he may be restless, trembling, and alarmed, though there is but slight, if any, actual danger. The wound itself, though on the surface simple, may be serious within—the peritoneum being punctured, lacerated, contused, or widely detached; or some deep vessel may be injured, and alarming hemorrhage may be going on. Again, the wound may be large and lacerated at the surface, whilst little or no damage has been done to the deeper structures. Wounds of the abdomen not immediately fatal, but which subsequently terminate fatally, do so in much the same general way. Just as wounds of the head lead to death by delirium or coma, and wounds of the chest by dyspnoea, hæmoptysis, and syncope, so wounds of the abdomen kill by inflammation and gangrene, and the signs of these processes are tympanites, vomiting, hiccough, thirst, a sense of bursting, clammy sweats, and distressing restlessness.

SIMPLE PENETRATING WOUNDS are unattended at first by any other symptoms than those common to non-penetrating wounds of a corresponding character. If all goes well, and the patient makes a good recovery, as in many incised penetrating wounds is the case, there is neither collapse to start with, nor peritonitis to retard the cure; and even when the injury has been followed by a good deal of shock, the subsequent course of the case may be quite simple and satisfactory, the symptoms negative, and the convalescence quick. In many cases, especially if the wound is narrow, or oblique, it is difficult or even impossible to say whether it penetrates or not, unless the surgeon indulges in an unwarrantable curiosity and probes the wound. The case may, therefore, run its course to a successful termination, and the surgeon be left in doubt whether he has had a non-penetrating or a penetrating wound to treat. In drawing any inference as to whether the peritoneum has been penetrated or not, the varying thickness of the parietes as well as the force and direction of the blow, if this can be ascertained, and the size of the wound as compared with the shape and size of the instrument, must be taken into account. A force which would penetrate a thin abdominal wall may not a fat one; and a force which would drive an instrument quite through at the epigastrium may not go half-way through at the flank. Again, care must be taken not to mistake a lobule of fat, projecting from the wound, for a piece of omentum. One great source of danger in penetrating wounds was formerly supposed to be the irritation set up by the entrance of air; but John Bell

ridiculed this doctrine, and concluded: (1) that air could not really be thus admitted into the cavity of the abdomen, and (2) that even if freely admitted it was incapable of producing the dreadful effects which had been ascribed to it. With the substitution of "germs in the air," for "atmospheric air," the old scare is still existing, and the antiseptic spray is the antidote thereof. But as, from the most recent statistics of abdominal operations, performed with and without the spray, there is scarcely a fraction of difference in the results, and one is at a loss to know on which side the advantage really is, there is good reason to think that Bell's observations¹ respecting atmospheric air and its influence on these operations, may be applied with equal force to the modern theory.

But though the admission of air has not the evil influence imputed to it, the inflammation of the peritoneum which it is supposed to excite, does too often occur from other causes, and that too whether there be injury to the viscera or not. It has been written that a discourse on wounds of the abdomen must be a discourse on inflammation of that cavity, and on the various ways in which it is produced. Though this happily is a great exaggeration, it yet must be acknowledged that the slightest scratch or wound of the peritoneum, may, under some circumstances and in certain constitutional states, excite general peritonitis. As a rule, however, the inflammation excited by wounds results from some injury to the viscera, and from the escape, into the cavity of the peritoneum, of some fluid or foreign substance which even the active, absorbent power of that membrane cannot remove. A limited amount of inflammation, such as fortunately follows the majority of simple wounds of the peritoneum, terminates in union by adhesion; and this purely local process rapidly heals the injury, without giving rise to any symptoms or causing any disturbance within the abdomen. But it sometimes happens that the inflammation, instead of being restricted to the lips of the wound, extends very widely over the surface of the peritoneum. It is the tendency of inflammation when it attacks a shut sac, no matter how slight the cause, nor how small the area first affected, to run rapidly over the whole of its surface; and it is this tendency which gives the danger to peritonitis: (1) because of the large number of organs necessary to life, which are covered by the peritoneum and are thus affected by the inflammation of that membrane, and (2) because of the extent of this serous membrane and of the irritation excited by the products of its inflammation.

In a wound of the abdomen, as in one of the pleura, pericardium, a large joint, or a large vein, the inflammation spreads widely over the lining membrane, if its surfaces are not brought into contact, so that they can adhere; on the other hand, if the wounded surfaces touch each other, the inflammation is limited by its own adhesive tendency. Thus it is that inflammation of the peritoneum, though the chief cause of danger in simple penetrating wounds of the abdomen, is also the only means of cure, by causing adhesion of surfaces and closure of the wound. Constitutional disposition and visceral degeneration influence the character of local inflammation, wherever situated; and there is, probably, an essential difference between the circumscribed, salutary inflammation which closes a wound, and the pernicious and too often fatal inflammation which spreads indefinitely by continuity.

The symptoms, diagnosis, pathology, and treatment of traumatic peritonitis have been already fully described, so that there is no occasion to refer further to the subject here. How severe a wound, even of the lacerated kind, and involving a large tract of peritoneum, may be entirely and quickly

¹ Discourses on the Nature and Cure of Wounds, 3d ed., p. 347.

recovered from, is shown by the following case recorded by Sir James Macgrigor for Dr. Kennedy.¹

A man employed at the Chank fishery near Manaar was bitten by a shark. The upper jaw of the animal had been fixed in the left side of his belly, forming a wound of nearly a semicircular shape, of which about one inch on the left side of the umbilicus was the upper, the lower part of the upper third of the thigh the lower extremity, and an inch behind the trochanter the centre. The abdominal and lumbar muscles were divided and turned up, exposing the colon in its passage across the belly, and several convolutions of the small intestines, and laying bare three of the lowest ribs; the gluteal muscles were lacerated and torn up; the tendons about the trochanter were divided, laying bare that bone, and the vastus externus and part of the rectus muscle of the thigh were cut across. The lower jaw of the fish had been fixed in the muscles of the right side of the abdomen, forming a segment of a circle between the umbilicus and one inch above the pubes; the teeth of this jaw had penetrated without otherwise lacerating the tissues. The measurements of the wound were 19 inches in length by between 4 and 5 in breadth. The accident had occurred three hours, and the patient had been carried first in a boat and then in a palanquin over five miles, before he was seen by Dr. Kennedy, who freed the abdomen from salt water and blood, and cleansed the wound from clotted blood and hair, closing it with straps of adhesive plaster around the body, a light dressing, and a many-tailed bandage. As the bowels had not acted for two days previously, a clyster was ordered the same evening, and was followed by two actions, one immediately and the other during the night; he was bled the next day, opium was given as required, castor oil was administered from time to time, and a light, fluid diet was ordered. The opening into the abdomen had perfectly closed by the sixteenth day, the whole of the wounds granulated, and the man did well.

Treatment.—Such a case as the above should encourage the surgeon to hope even against hope in the treatment of penetrating wounds. Every attention should be given both to the local and general treatment of the patient, as if there were certainty of recovery if only all proper care were taken. Indeed, it should be a rule in surgery that nothing, whilst life lasts, should be treated as hopeless, whatever we may think about the result. By insisting on this principle of action, I have more than once witnessed recovery under the most desperate circumstances, and when the disposition of the attendants was to give up the case as lost. The wound having been cleansed, bleeding checked, sutures inserted, and some light, elastic, and antiseptic dressing applied, the patient should be placed in a comfortable position so as to relax the abdominal muscles. The sutures in all cases of penetrating wound of the abdomen should be passed from the peritoneum outwards, the whole thickness of the parietes, including the peritoneum itself, being traversed. The general treatment consists in bleeding, by leeches on the abdomen or by venesection at the elbow, if the patient be plethoric or the inflammation run high; in the administration of low diet and the strict avoidance of solid food; in the enforcement of absolute quietude, with the use of opium to relieve pain and check peristaltic action of the intestines; and in the employment of enemata to clear the rectum if necessary.

PENETRATING WOUNDS WITH PROTRUSION OF UNINJURED VISCERA.—The peculiar arrangement in planes of the abdominal muscles, the direction of the fibres of each of which differs from that of the others, allows of the parietes being wounded to a considerable degree without protrusion following; yet if the wound be in a part where the aponeurotic structures prevail, a considerable prolapse may take place through a small incision. Perhaps, however, it may be stated roughly that the degree of protrusion will be in proportion to the size of the wound, and that the viscus protruded will

¹ Med.-Chir. Trans., vol. ix. p. 240.

depend on the anatomical contents of the region wounded. The small intestines and the omentum have the greatest tendency to protrude, but any portion of the intestinal canal, from the stomach to the sigmoid flexure, may be forced through the wound. The duodenum, unless dragged with the stomach, is rarely, if ever, protruded; and the cæcum and sigmoid flexure are less likely to escape than the transverse colon. The bladder has occasionally protruded through a wound in the hypogastrium. It is recorded that the solid viscera have been partially or entirely protruded, but such cases are more rare. Incised and lacerated wounds are more frequently followed by these protrusions than punctured or gunshot wounds.

Treatment.—When the wound has been recently inflicted, and the protruded organ is uninjured, it should be returned to the abdominal cavity without delay. This should be done in a definite and methodical manner, returning those parts first which have protruded last, and beginning at the upper end and following in the regular course of the intestine; the stomach should go before the small, and the small before the large bowel, and omentum after intestine. If the protruded parts are dirty and covered with sand or hair, etc., they should be washed clean by a gentle stream of warm milk and water, or of warm water squeezed from a clean sponge, or allowed to flow from an irrigator, until every particle of foreign substance is removed; and then they should be returned. In returning them, care must be taken not to force them between the different planes of the abdominal wall, or into the sheath of the rectus, or between the peritoneum and the pelvic cellular tissue instead of into the peritoneal cavity. It should be borne in mind that the peritoneum in old people, and in certain regions, is very easily detached, and that it has happened that large portions of protruded viscera have been forced into false sacs so formed, instead of into the abdomen. To avoid this, it is best to follow the returning mass with the finger, and thus ascertain that a clean, smooth sweep can be made upon the inner surface of the parietal peritoneum.

There may be obstacles to the return of the protruded structures:—

In the first place, the *narrowness of the aperture* may resist the efforts of the surgeon. To obviate this, the abdominal parietes should be relaxed by position as much as possible, and retractors should be inserted so as to separate the margins of the opening and prevent them from being pushed back by the taxis. If these measures are insufficient, the opening should be enlarged with a probe-pointed herniotome or bistoury, dividing first the aponeurotic or muscular tissues, and sparing the peritoneum if possible. In making this incision, care must be used not to wound the intestine, nor to divide any large artery, nor to cut across the direction of the muscular fibres, which would leave the parietes permanently weakened. If a probe-pointed knife cannot be passed between the edge of the wound and the protruding organ, the wound should be enlarged by carefully cutting through the tissues from the surface, with a sharp-pointed scalpel.

If it be *omentum* protruding, reduction may be difficult or impossible on account of its congested and œdematous state, or because it is adherent to the edges of the wound by lymph poured out into its meshes; or reduction may be undesirable on account of its inflamed or even gangrenous condition. If it be quite healthy, and the patient be seen within a short time of the accident, and if the reduction fails simply on account of the size of the protrusion as compared with the size of the wound, this should be enlarged in one of the ways just specified. But if it be deeply congested, partially strangulated, inflamed, or adherent to the wound, it is unwise to return it into the peritoneal cavity. The proper plan is to apply one or more ligatures to it, on a level with the edges of the wound, to cut the ligatures short, and to cut away the part of the omentum beyond the ligatures, leaving the stump

at the wound if it be already adherent to its edges, but returning it just within the abdomen if it be not adherent. Before thus treating omentum, care should always be taken that no knuckle of bowel is hidden within or behind it; and also that the prolapsed portion is not such that, after cutting it away, a loose, unattached end shall be left in the abdominal cavity. I have on two or three occasions seen the protruded omentum forming a complete sac, with a large knuckle of intestine within it. I have also, at a post-mortem examination, found a piece of omentum, about four inches by two, lying loose and gangrenous in the abdominal cavity; the omentum had been doubled upon itself, and an elongated loop of it had protruded; this the surgeon had tied with a double ligature and cut away, leaving one ligature upon the lower end of the mass, and the other upon the upper end of what proved to be a portion thus completely separated from the rest. Death was caused by peritonitis, set up by this detached piece of omentum left in the peritoneal cavity. Such a fatal error would be avoided by carefully unravelling the omentum before tying it, and, if such a condition as the above were found, and the omentum were not in a fit state to return, it would be best either to draw out the free end before ligaturing it, or to leave the omentum to form adhesions at the wound, after which the projecting part could be removed if it did not slough away; in either case the stump would cicatrize in the wound. If the omentum be gangrenous, there can be no question as to the propriety of removing it after the application of a ligature to its base, bearing in mind the precaution just stated. The ligatures should be of cat-gut or good silk, and should be cut off half an inch beyond the knot.

When the omentum is allowed to slough, the patient suffers pain and uneasiness about the wound, and over more or less of the abdomen, and often has a feeling as if a cord were tied tightly around the belly. He has also a sensation of nausea, or actually vomits, and in a short time the symptoms of general peritonitis ensue. The protruded omentum first adheres to the edges of the wound and the subjacent parietal peritoneum, a quantity of serous fluid is poured out, and it swells from venous congestion. It loses sensitiveness and becomes discolored, being mottled, bright-red, and dusky-brown, then deep-purple, and, lastly, dingy-black; it is then thrown off like other sloughing tissues. The remainder is healthy-looking and granulating, and gradually contracts as it cicatrizes, until it leaves a scar on the level of the skin, or slightly cupped and depressed below it. Many surgeons of great repute have advocated the plan of leaving the omentum to slough; it was strongly advised by Key, recommended by Guthrie, and preferred by Poland; but it cannot be gainsaid that excision obviates the tediousness of the sloughing process, while experience has shown that the ligature, when properly applied, is not attended with the dangerous consequences attributed to it. Moreover, it is absolutely demanded when the omentum is not fit to be returned, and yet the constricting force at the wound not sufficient to effect separation by sloughing. In operating for hernia I have often ligatured and removed large portions of the omentum, and have had no reason to question the safety and success of this mode of treatment.

Protruded *intestine* may be irreducible from one of several causes, or may be partially strangulated, or completely gangrenous. It may so increase in size from accumulated gas, that reduction is impossible until the gas is pressed out, or allowed to escape through an aspirating tube, or until the parietal wound is enlarged. This latter step must be taken with great care, however, because of the difficulty in preventing fresh portions of the gut from protruding through the enlarged aperture, when flatulent or fluid distension is general. Puncturing the distended and protruding gut has been advocated by many surgeons, including Paré, Garengéot, Sharp, Van Swieten, and several modern authori-

ties ; and it has been in some cases very successful. But it has its dangers, and especially if the distension has been great and prolonged, and if the intestinal coats are softened by inflammatory changes. Under these circumstances the puncture-holes are apt not to close, but to allow of leakage of the intestinal contents. I have seen this catastrophe necessitate the establishment of an artificial anus, and have more than once witnessed the use of circular ligatures to close the openings. It is a practice which should never be pursued in an inflamed, over-stretched, softened, or otherwise diseased bowel ; and even in healthy tissues it should be avoided, if by gentle manipulation and moulding of the protruded gut, or by moderate enlargement of the opening, reduction can be otherwise effected. But the bowel may also be irreducible owing to the protrusion with it of omentum, which has become congested and œdematous ; in this case the omentum should be treated by ligature and removed, and then the bowel should be returned. Again, adhesions may have formed between the bowel and surrounding parts, at or outside the opening, in which case they must be gently broken down or divided, when, after stopping bleeding, if there be any, the intestine can be replaced. If the bowel be strangulated, it may be in one of three conditions : (1) simply congested ; (2) actively inflamed ; or (3) actually gangrenous. Respecting the two former conditions, there can be no doubt that the practice to adopt is the same as in hernia—viz., the opening should be enlarged, and the bowel returned as soon and as gently as possible. There is no place like home for a sick bowel, as for a sick man. But if the gut be in a state of gangrene, commencing or complete, it is death to the patient to return it to the peritoneal cavity ; it is to cast the corrupt and festering carcase into the chamber of the living—to poison life by the putrefaction of death. If, then, the bowel has lost its polish, and is of a dusky or brownish-black color ; if its coats tear readily and are tumid and swollen ; still more, if there are greenish or ashen-gray spots in them, the surgeon—knowing that such conditions are past repair, that sloughs must separate, and that an artificial or false anus must form—should leave the bowel in the wound, and wait for the formation of a false anus, or else perform enterectomy. If the former plan be selected, and all goes well, adhesive inflammation will attach the gut firmly to the edges of the parietal wound, the peritoneal cavity will be safely cut off before the sloughs separate, and there will be then no danger of fecal extravasation into it. On the other hand, pain, vomiting, abdominal distension, weak pulse, and general depression, may point to an unfavorable termination from collapse or inflammation ; or the false anus may be so high up in the bowel that, the chyme escaping through it, death will occur sooner or later from inanition. It may here be mentioned that, as the portion of bowel below the strangulation is empty and contracted, the nearer the seat of strangulation is to the stomach, the less distended will be the abdomen, and the quicker and more severe will be the symptoms. Enterectomy in these cases, therefore, should be performed.

Remarkable cases of recovery after wounds of the abdomen with protrusion, are related by Mr. Hayne,¹ by Dr. Shearman,² and by Bransby Cooper.³ B. Cooper says:—

I have heard my colleague, Mr. Morgan, relate a case, in which a boy at Tottenham received a wound in the abdomen through which a large quantity of intestines protruded ; he placed the viscera in his pinbefore and walked a considerable distance to a surgeon, who freed the bowels from a quantity of dust which adhered to them, returned them into the cavity of the abdomen, and sewed up the wound by the uninterrupted suture ; by this judicious treatment the patient was restored to health.

¹ Edin. Med. and Surg. Jour., vol. v. p. 129.

² Provincial Med. and Surg. Jour., Aug. 1845.

³ Surgical Essays, p. 264

Protrusion of the *solid organs* is a rare occurrence, but several cases are on record. In some instances, portions of the liver have been cut off, either without or after applying a ligature around the protruding part. Dr. Macpherson's case,¹ and one quoted from Dieffenbach's journal by Professor Dunglison, may be referred to. Recovery has followed the removal of a protruding spleen, of a kidney, and of a large part of the pancreas.²

The *treatment* to adopt in such cases ought to depend upon whether the protruded organ is wounded or not, and how long it has been protruded. If it be not wounded, and the case be seen directly, the proper practice is to return it, and to this end the wound in the parietes should be enlarged, if necessary; if wounded, or if the organ be damaged from long exposure, it is unsafe to return it; a ligature should be applied, and the protruded part cut away, if it be the liver which is involved. In the case of the kidney, and perhaps also of the spleen, the whole organ must be excised. Dr. Blundell³ states that Mr. Cline used to relate the case of a soldier whose side was laid open by a sabre-wound through which the spleen protruded, and lay out in the dirt for some hours. It was removed by the surgeon, and the man recovered without any subsequent inconvenience. A case is recorded⁴ in which the spleen, after being protruded for twenty-four hours through a wound in the left hypochondrium, was found irreducible, cold and black; a strong, waxed thread was tied around it, above the unsound part, and $3\frac{1}{2}$ ounces of the spleen were cut away; another ligature was then required, to a large spurting artery, and after the parts were well bathed with warm water, the rest of the spleen was returned, with the threads hanging out of the wound. On the tenth day the threads were removed, and ultimately the man got quite well. In this case the patient had difficulty in passing water for eight days; and in another case referred to by Dr. Blundell, in which the whole spleen separated completely from the body on the twentieth day after the wound, and the eighteenth day after the application of the ligature, there was bloody urine till the tenth day; but the man was well by the forty-fifth day.

Protrusion of the uninjured *bladder* occasionally, though very rarely, occurs. Just as it has been observed as a rare occupant of a hernial sac, so in exceptional cases the bladder has projected through a wound in the lower part of the abdominal parietes. Samuel Cooper saw three such cases at Brussels, after the battle of Waterloo.

Before such a thing can occur, the capacity of the bladder must have been greatly increased by over-distension of its walls. Protrusion of the bladder through a wound in the abdominal walls may occur without penetration of the peritoneal cavity; and even when this is opened, the prolapsed part of the bladder is only partially covered by peritoneum, but the greater the prolapse the more extensively is that membrane involved. When protruded, the bladder forms a soft, compressible swelling, which, as a rule, is easily reduced by pressure, the reduction being accompanied by an urgent desire to pass water. The *treatment* consists in reducing the protrusion, and in introducing a soft catheter, which should for a time be retained.

The treatment of all wounds of the parietes, after the reduction of protruded viscera, is the same as that of simple, penetrating wounds. In passing the sutures, care must be taken not to injure any of the viscera, and not to allow blood to trickle from the punctures back into the peritoneal cavity; both these objects are attained by introducing a flat sponge, if the wound be a large one, and spreading it out upon the viscera until all the stitches are

¹ Med. Gaz., January, 1846.

² See section on Penetrating Wounds of Pancreas.

³ Blundell's papers in Dr. Ashwell's Practical Treatise on Parturition. London, 1828.

⁴ Philosophical Transactions, vol. xl. p. 425.

introduced; it should then be withdrawn before tightening the last suture. If the omentum or bowel be left projecting at the wound, the edges should be brought together only in part by sutures. It is not necessary to stitch the bowel or omentum to the wound, and no ligature should be left projecting at the wound if the stump of tied omentum is returned into the cavity.

PENETRATING WOUNDS WITH PROTRUSION OF INJURED ORGANS.—In these we have the additional complication of a wounded viscus, which, as regards protrusion, may be in any one of the conditions described in the foregoing section. It will only be necessary to refer here to the various kinds of wounds of the viscera, and their treatment and results, without reiterating the remarks relative to protrusion. The appearances of *wounded intestine* have been described by Haller,¹ Benjamin and John Bell, Travers, Gross, and many others. Travers² writes, “before adverting to the consequences of wounds inflicted upon the exposed intestine, it will be necessary to describe certain appearances which the wounds exhibit, *depending upon the action of the bowel*. If a gut be punctured, the elasticity of the peritoneum and the contraction of the muscular fibres open the wound, and the villous or mucous coat forms a sort of hernial protrusion and obliterates the aperture. If an incised wound be made, the edges are drawn asunder and reverted, so that the mucous coat is elevated in the form of a fleshy lip. If the section be transverse the lip is broad and bulbous, and acquires tumefaction and redness from the contraction of the circular fibres behind it, which produces, relatively to the everted portion, the appearance of a cervix. If the incision is according to the length of the cylinder the lip is narrow, and the contraction of the adjacent longitudinal, resisting that of the circular fibres, gives the orifice an oval form. This eversion and contraction is produced by that series of motions which constitute the peristaltic action of the intestines.” From his experiments, he concludes that, if the gut is cut across, the orifice to some extent opens and closes alternately by the muscular motions of the bowel, so that the contents are alternately ejected and arrested; if the wound is longitudinal, that is, in the axis of the bowel, the aperture remains patent, there is but little alternate contraction and dilatation, and the contents issue freely. In the punctured wound, the mucous coat is everted and constantly fills the opening, and is elevated somewhat above the peritoneal surface; “it was the only form of wound not followed by effusion. In the lacerated wound, the eversion was so slight as to be scarcely perceptible.” There is less tendency for transverse than there is for longitudinal wounds of the bowel to be spontaneously repaired, owing to the greater disposition of the edges of the transverse wound to recede from one another, and to have their mucous coats everted; thus, union by adhesive inflammation is frustrated.

Treatment.—If the wound be a small one, of the punctured variety, there is but little danger that the contents of the bowel will escape, and many distinguished surgeons have recommended that no ligature should be applied; but Le Dran, Benjamin Bell, Travers, Astley Cooper, Key, Poland, and many modern surgeons, have advised the application of a ligature before returning the bowel, so as to avoid the risk of extravasation. If the wound be small, the ligature may be applied around it in the same way that a string is tied around the neck of a sac, and the ends of the ligature should be cut short. If the wound be larger, it is better to close it with a continuous suture, using a small, round, sewing needle, armed with a fine silk thread, the ends of which

¹ Element. Physiol., lib. xxiv. sect. 2, and Opera Minora, tom. i. sect. 15.

² An Inquiry into the Process of Nature in Repairing Injuries of the Intestines, pp. 85, 86.

should be securely fastened and cut off short. The gut is then to be returned, and the external wound to be treated as if the injury had been a "simple penetrating wound." If the wound be incised, and especially if not quite a small one, it must be stitched up with one of the various kinds of suture to be presently described, preferably the glover's,¹ the spiral, Lembert's,² or Gely's,³ before the bowel is returned. If the bowel be divided completely across, so that the incision involves, it may be, even the mesentery, the ends should either be stitched together in part of their circumference, and to the edges of the parietal wound in the remaining part, after the bulk of the protruded bowel has been returned; or the edges of the divided gut should be accurately united all around with their peritoneal surfaces in contact, and then returned to the abdomen, and the wound in the parietes closed in the usual way. By the former method a false anus will result; there are a variety of plans for executing the second. The former should be adopted if, owing to the age or feeble condition of the patient, or the contused state of the edges of the wound, there be reason to fear that adhesive inflammation will not take place; but if the wound be an incised one, if the patient be in fairly good health, and further, if the wound involve the upper part of the intestine, so that there would be fear of death from inanition if a false anus were formed, the complete suture should be employed, the bowel returned, and the external wound closed. If the protruded wounded bowel be also gangrenous, or if the contused or lacerated character of the wound make it probable that a slough will follow, either a false anus should be allowed to form, or, what would be still better when the circumstances of the case permitted it, enterectomy and the union of the divided ends by Lembert's or Jobert's suture⁴ should be practised.

Effusion into the abdominal cavity rarely follows a wound of the protruded *stomach*, as the contents easily escape outwards; the act of vomiting expels them through the wound as well as through the *œsophagus*. If the wound be small, the prolapsed portion of the stomach may be left in the external wound, with the prospect that the gastric wound will close and be completely retracted within the abdomen, and that subsequently the external wound also will close. If the wound in the stomach be large, it should be closed by suture, but in spite of sutures the healing may be hindered by a fistulous opening. If the edges of the wound in the stomach are bruised or lacerated, it will be advisable to retain them by a suture to the edge of the parietal wound; a fistulous opening will in such a case result, at any rate for a time, but there is generally a tendency for the stomach's walls to be dragged back into the belly, when complete and permanent closure takes place. It does not follow, because a cure of a wounded gut or stomach has been obtained with the attendant disadvantage of an abnormal opening, that a permanent fistula will remain. There are many cases on record in which, after several months, the opening has quite closed. Again, it does not follow, if the wounded bowel or stomach be left in the external wound there to undergo repair without the aid of sutures, that an abnormal anus will ensue even temporarily, as union by adhesive inflammation occurs at once in some such cases. In no instance in which a wounded viscus has been treated by sutures, and returned into the abdominal cavity, should an attempt be made by means of a suture to retain it near the wound in the abdominal wall; but the external wound should be closed, and the case treated precisely as one of "simple penetrating wound."

Terminations.—Thus it will be seen that protruded, wounded intestine or stomach may heal after being returned to the abdominal cavity, and that the

¹ See Vol. II., page 29, Fig. 226, *supra*.

² See Vol. II., page 197, Figs. 300-302, *supra*.

³ See Vol. II., page 198, Figs. 304-305, *supra*.

⁴ See Vol. II., page 197, Fig. 299, *supra*.

cure may be quite complete, in some cases after, in others without, sutures having been used; that the cure may be effected without an abnormal opening, though the wounded viscus become fixed to the parietal peritoneum beneath the external wound; that the cure may be attended with a false anus or fecal fistula, which may or may not close after a longer or shorter time; that recovery may take place after the dangerous and somewhat complicated proceeding of enterectomy; or, finally, that death from peritonitis or collapse may occur in consequence of primary or secondary effusion of the contents into the peritoneal cavity, or even without such effusion taking place.

The mode of union of wounds of the intestine, whether by means of the suture or through the agency of unassisted nature, is precisely the same. Travers says "it commences with the agglutination of the contiguous mucous surfaces, probably by the exudation of a fluid similar to that which glues together the sides of a recent flesh-wound when supported in contact. The adhesive inflammation supervenes and binds down the reverted edges of the peritoneal coat, from the whole circumference of which a layer of coagulable lymph is effused, so as to envelop the wounded bowel. The action of the longitudinal fibres being opposed to the artificial connection, the sections mutually recede as the sutures loosen by the process of ulcerative absorption. During this time the lymph deposited becomes organized, by which further retraction is prevented and the original cylinder with the threads attached to it are encompassed by the new tunic. The gut ulcerates at the points of the sutures, and these fall into its canal. The fissures left by the sutures are gradually healed up; but the opposed villous surfaces, so far as my observation goes, neither adhere nor become consolidated by the granulation, so that the interstice marking the division internally, is probably never obliterated." An inspection of the external surface of the intestine would not, however, discover even at a recent period after the injury the spot at which the division had taken place. Travers (and from his earlier experiments, Reybard also) was of opinion that the edges of the divided mucous membrane never united with each other, but that the interspace between them was occupied by organized lymph, and that this formed a complete cicatrix adhering to both the serous and muscular coats. Travers remarks that "the adhesion which takes place between the mucous surfaces in a few hours after their connection by suture, is in no instance permanent, being destroyed by the retraction of the divided parts when the sutures loosen. But if this retraction could be prevented and the mucous surfaces were retained in contact, it is probable that no organized and no permanent union could take place betwixt them, for the internal coat of the bowel is indisposed to the adhesive inflammation."¹ It is on this account that the sutures, when cut short and not left projecting from the external wound, always pass into the canal; when left long and projecting from the external wound, they ulcerate towards the serous surface and escape through the peritoneal cavity. This is one of the great dangers of the practice of leaving the sutures long and communicating with the outer wound. Other writers, such as Pétrequin, Jobert, and Gross—and Reybard also, from his later experiments—conclude that the mucous coat can cicatrize completely like the other tunics. Gross remarks that the adhesion of the mucous membrane, though achieved more slowly than that of the other tunics, is ultimately complete and may occur in one of two ways: (1) either the edges come into contact by the gradual absorption of the effused lymph, and then coalesce after a period varying from a few weeks to as many months; or (2) sometimes, but not often, the breach in the mucous membrane is healed by granulations. Pétrequin

¹ Inquiry into the Process of Nature in repairing Injuries of the Intestines, etc., p. 131.

points out that though the mucous tunic is regenerated, yet the villous surface is thinner than natural, and a slight depression exists at the seat of suppuration. Jobert, in support of his view that the mucous membrane is reproduced at the line of division, quotes a case recorded in the *Lancet* for 1848. Dr. Thompson, Regius Professor of Military Surgery in the University of Edinburgh, showed that it was sufficient for the purpose of union to include only the peritoneum in the suture. Travers states further that the uniform contiguity of the peritoneal surfaces, and their ready disposition to assume the adhesive inflammation, are the means provided by nature for the reparation of intestinal wounds and injuries;¹ and that by this method of nature, punctured and small incised wounds, transverse or longitudinal, and apertures caused by excision of gut-substance, readily admit of spontaneous cure. Travers even thinks it just possible that, under certain conditions, the intestine, after having been half divided, may be imperfectly restored by this same method of nature; but that complete division (or what he calls direct division) of the tube is irreparable except when effected by the action of a stricture (which is what he calls indirect division), natural or artificial, in which case the injury admits of perfect and speedy recovery. In his well-known experiment of applying a ligature around the duodenum of a dog, the ligature ulcerated through into the bowel, the canal of which was perfectly re-established; a transverse fissure marked the seat of the ligature, and the appearances corresponded with those of union after suture. The dog had quite recovered by the fifteenth day after the operation, when he was killed and inspected.² Dr. Gross repeated this experiment, and found that the period requisite for the escape of the ligature was very variable.

A ligature which includes a portion of the intestinal wall, such as that sometimes adopted for punctured wounds, is followed by adhesive inflammation, and thus the ulcerated wound made by the ligature is closed in the same way as a simple incised wound of the bowel. Sutures, in whatever way introduced, except when the ends are retained at the external wound, separate inwards and pass off through the anus. In the case of sutures of any absorbable material, such as catgut, it is probable that the ulcerative process does not extend into the canal, and that the knots of the sutures are for a time, that is, until their complete absorption, encysted. The species of suture is of secondary importance, provided that the cut ends of the bowel are brought into accurate contact throughout their entire circumference; if this be done, the mode of repair proceeds on the lines above stated; and, with the exception that the cylinder of the bowel is maintained through the instrumentality of the sutures, instead of by the supporting contact of surrounding structures, the same uniform principle is followed after sutures as in spontaneous union.

The solid organs—the liver, spleen, kidney, and even the pancreas—are not excepted from the liability of being protruded and injured. (See the special sections on injuries of those organs.)

PENETRATING WOUNDS WITH INJURY TO, BUT WITHOUT PROTRUSION OF, THE VISCERA.—These are even more serious than those of the last group. They differ from them, too, in that it is often impossible to recognize them. There is no doubt about the nature of an injury when the wounded viscus is protruding, but there are no certain means of verifying a wound, at least at the outset, when the viscus is not protruding, save by the escape of feces, bile, urine, or the ingesta, through the outer wound. The abdominal viscera are always naturally in accurate contact with the parietes, and that penetrating wounds

¹ *Op. cit.*, p. 133.

² Travers, *op. cit.*, p. 98, Experiment O.

do not always involve the subjacent viscera, is due to the readiness with which these are displaced. But the question at once arises, if the stomach or intestines are wounded, and their contents are not evacuated externally, whether they will escape into the abdomen. Now in these wounds, as in those followed by protrusion, the viscera may be either punctured, incised, contused, or lacerated; and much depends upon the character of the wound as to whether effusion of the contents will occur or not. Other circumstances also influence this event. Thus, if the intestinal tube be full, or nearly so; if the wound be large; if it be in the longitudinal axis of the bowel, so that the circular fibres cause it to gape instead of to contract, as is the case in a transverse wound; or if the opening be lacerated, or ulcerated, so that the mucous coat does not protrude through the wound in the other coats, the contents will escape rapidly. Whereas, if the tube be empty, or nearly so, and the wound be a punctured or small incised one, there will be little if any tendency to extravasation. The equal and uniform pressure within the abdomen opposes an efficient, though passive, resistance to the effusion of the visceral contents, and this too even in cases in which the wounds are not of very small size. Effusion may be anticipated in proportion to the degree in which this passive resistance is overcome by the circumstances of the injury; thus, if the gut be full and the wound extensive, there is little or none of this passive resistance to the natural action of the bowel to expel its contents. There seems abundant proof from experiments and reported cases, that effusion does not usually occur unless these two conditions (repletion and extensive wound) are combined; but an exception must be made as to cases in which air or blood has been extravasated into the abdomen at the time of the injury. That the integrity of the abdominal parietes does not prevent the escape of the intestinal contents, is proved by the greater frequency of effusion in cases in which, without any injury to the abdominal walls, the bowels or stomach are ruptured, or perforated by ulcers, or by worms or other foreign bodies. The explanation of this is to be found in the nature of the injury to the bowel. A rupture by concussion or compression, is seldom of small size, and, as a rule, takes place when the tube is distended; and a perforation by ulcer, being attended by a loss of substance more extensive on the mucous than on the peritoneal surface, is not a mere solution of continuity like a puncture or incision. On the other hand, effusion is not facilitated by the division of the parietes, unless the opening be large enough to admit of prolapse. There is no lack of cases in which recovery has followed after the abdomen has been completely transfixed by sword, bayonet, or fire-arm missile; or after a penetrating wound followed by the passage of the instrument by the anus. Travers¹ has collected many such, in some of which the patients were up and about by the eighth or tenth day. Wiseman inferred that in these cases the weapon "passeth through the body without wounding any considerable part." Garangeot thought likewise. But thanks to experiments and accurate pathological observations, we see now, as John Bell² wrote, "how this is to be explained; for we know that in a thrust across the abdomen, six turns of intestine may be wounded, and each wound may adhere; adhesion, we know, is begun in a few hours, and is perfected in a few days; and when it is perfect, all danger of inflammation is over; and when the danger of inflammation is over, the patient may walk abroad; so that we may do just as old Wiseman did in this case, 'bleed him, and advise him to keep his bed and be quiet.'" It is surprising that John Hunter, though he recognized the fact that wounded intestines quickly adhered to one another, "especially near to the wounds;" and though he described in detail

¹ Op. cit., pp. 29-35 and 59-65.

² Op. cit., p. 330.

the autopsy of a case in which the third part of the duodenum and three coils of jejunum had been penetrated, without any extravasation occurring, by a ball fired in a duel in Hyde Park, on September 4, 1783, should yet have concluded, when describing another case in which the ball passed through from front to back of the abdomen, that none of the intestines were wounded, because there was no blood in the stools, and no symptoms of extravasation of the contents of any viscus. It is quite as surprising to read, that a case in which a minié ball of large size passed directly from rear to front through the belly, almost through the centre of the intestines as they lie coiled up in the abdomen, and in which "it is very certain that the ball passed in a direct line and was not deflected," but in which no fecal matter was discharged through either orifice and no pus by the rectum, should be cited as proof "that Malgaigne's denial of penetrating wounds of the abdomen without visceral injury can only be accepted in a restricted sense."¹

Symptoms.—These vary in different cases and in different constitutions, from those of mere temporary shock, with the mildest possible form of local adhesive inflammation, to all the symptoms of a most severe and widespread peritonitis. This may be most insidious in its onset; three, four, or even eight days may elapse after a stab in the abdomen, involving the intestines in more than one place, without any symptom being evinced; then obstinate vomiting suddenly sets in, and the patient is carried off in a few days by peritonitis.²

When effusion into the abdomen occurs, the course of the case is generally that of the most acute and fatal form of traumatic peritonitis. When effusion takes place externally, the symptoms may be limited to more or less shock and local tenderness, followed within a few days by recovery with a temporary fistula. When neither internal nor external effusion occurs, the patient may recover without ever having had any symptom indicative of a severe abdominal wound; or, on the other hand, severe peritonitis accompanied by high fever, jaundice, diarrhoea, bloody urine, bloody stools or vomit, or perhaps by the passage, within a period of from a few days to three or four weeks after the injury, of a bullet or other foreign body by the rectum, or of some fragment of clothing by the urethra—one or other of these symptoms—may give the case a very grave aspect for a time at least, though recovery will ultimately follow. Suppuration or sloughing about the external wound may continue for some weeks, but healing after a time will take place by means of granulations.

Diagnosis.—Unless it is followed by the escape externally of the contents of the viscus, a penetrating wound, with injury to an organ, can only be diagnosed from a simple penetrating wound if blood be passed by the rectum, or vomited, or voided with the urine; or if the missile, or some foreign body, such as a piece of clothing carried in by the weapon, is passed through one of the natural outlets of the body; or, in the case of the bladder, if at the time of the injury the bladder is known to have been full, and afterwards nothing but blood, or blood with a little urine, can be voided or withdrawn. A visceral wound may be fatal by hemorrhage, causing syncope, or oppression of the sympathetic by the weight of the effused blood; but there are no means of knowing the exact source of the bleeding; it may be from a deep vessel in the parietes, or from a wound of either of the solid or hollow viscera. If effusion of the visceral contents occurs into the abdominal cavity, but not outwardly, and inflammation is excited, we cannot even then be quite sure that the peritonitis has been set up by effusion, and not simply by the wound

¹ Med. and Surg. Hist. of War of Rebellion. Second Surgical Volume, p. 204.

² Two cases are recorded by La Motte and quoted by Travers (op. cit., p. 78).

of the parietal peritoneum. If effusion of bile, urine, or fecal matter has taken place to any extent, the immediate symptoms will be distressing vomiting and nausea, acute pain, and restlessness, and some or all of the other symptoms characteristic of traumatic peritonitis; but this is all that can be said to be the invariable result of these effusions. We know that many wounds which have positively involved the viscera are not followed by effusion, but rapidly heal by adhesive inflammation; we know further that a small quantity of bile or feces, especially if very gradually effused, may be shut away from the general peritoneal cavity and become encysted, and that recovery after abscess may follow. Such cases should make us cautious in our treatment, and forbid unnecessary surgical interference. Further, we know that even large quantities of healthy urine may be for a time in contact with the peritoneum without causing fatal peritonitis, or may be shut up in a circumscribed space formed by adhesive inflammation and effusion of plastic lymph from the surrounding parts. But, lastly, we know that the common consequence of visceral effusion is death; though from the post-mortem conditions of cases, we are encouraged to believe that in many, had the diagnosis of extravasation been made and the abdomen explored, the effused matter might have been completely removed, the wound in the viscus closed by sutures, and thus a chance of recovery afforded. It is to be regretted, therefore, that our means of diagnosis of fecal or other extravasation are not more perfect; and the attention of surgeons should be directed to every circumstance which will tend to make them more so.

Prognosis.—There are two sources of apprehension special to these wounds, viz., lest extravasated blood should conduce to the effusion of the contents of the viscera into the abdominal cavity; and lest the contents, when effused, should lead to fatal peritonitis. That effusion is a necessary, or even the ordinary, result of visceral wounds, both theory and experience disprove; and that reparation may be looked for in such wounds, the records of the profession indubitably show. These records further show that, whereas some cases have recovered so well and rapidly as to lead such men as Wiseman and others to believe that the viscera had altogether escaped injury; in others the inflammation has been so general and severe as to render the patients' recovery a surprise to their attendants. If the contents of the wounded viscus escape through the external wound, the prognosis is less unfavorable than when they escape internally; recovery with a fecal fistula, or a false anus, may follow; but the opening will, most probably, ultimately close.

Treatment.—If there be no evidence or suspicion of effusion from any of the organs, the external wound should be closed and treated in the manner recommended for "simple penetrating wounds." If there is escape of some of the contents through the external wound, this should be cleaned and lightly dressed with some warm, weak, carbolic-acid fomentation; but its edges should not be brought together, and the discharge should be permitted to flow freely into the dressings, or, through an opening in them, into some carded oakum, or a pad of peat-moss. If the case is seen within an hour or two, and through the external wound the stomach or intestine, or other hollow viscus, is seen to be wounded, the external opening should be enlarged sufficiently to allow of the visceral wound being closed by suture; and at the same time, if effusion into the abdominal cavity has taken place, scrupulous care should be given to the "toilette" of the peritoneum before closing the external wound. Again, if severe hemorrhage into the peritoneum occurs from wounded mesentery, omentum, or bowel, abdominal section for the purpose of removing the blood-clot, ligaturing the bleeding vessel, and suturing the visceral wound, will in some cases be followed by a successful result; though, of course, if

the source of bleeding be either the vena cava, aorta, or some large vascular surface such as a ruptured liver, it can hardly be expected that any good can follow from an exploratory operation. Probing and dilatation of the wound, except as part of some definite operation, cannot be too strongly condemned. The general treatment is simple: There should be complete abstinence from solid food, and for at least ten days or a fortnight after the injury only small quantities of nutritive fluids, given at definite intervals, should be allowed. Thirst may be slaked with small fragments of ice. The bowels should be kept perfectly quiet, and if their relief be demanded, this should be secured by enemata. The recumbent position, with the knees propped up by a pillow, should be rigorously observed. Opium or morphia should be given freely and often, so as to keep the mind and body gently under its influence; subcutaneous injections of morphia, or morphia suppositories, are good forms for the administration of the drug, and serve, besides, to relieve sickness, which is so commonly a troublesome symptom. The state of the stomach is a more important guide than the pulse. Travers says: "The intimate connection and lively sympathy subsisting between the digestive and vascular systems render the pulse an equivocal if not fallacious criterion of the morbid changes which are to ensue. But if the stomach is quiet we have little to fear. . . . How, then, shall the irritation of this organ be appeased, which, if it continues, is a never-failing omen of destruction? I would answer by the reduction of the system; early, free, and repeated blood-letting, general and topical, is the main remedy upon which I place reliance."¹

In most of the instances of recovery after severe inflammation, blood-letting has been early and freely resorted to, and many high authorities might be quoted in favor of this practice. Whilst sickness and intense pain continue, the state of the pulse need not, as Travers repeats, deter the surgeon from bleeding, as the apprehension of reducing the power of the system below the means of reparation is futile. The general treatment of these injuries is concisely stated by Dionis:² "Les saignées faites les unes près des autres, la diète exacte, les fomentations émollientes sur le ventre, sont presque les seules ressources de l'art, soit pour prévenir ces symptômes, soit pour y remédier."³

Penetrating wounds of the stomach vary in gravity according as there is or is not effusion of its contents; or, if effusion occurs, according as it takes place into the cavity of the abdomen or through the external wound. Cases have been recorded of death from wounds of the stomach unattended by effusion; but, as a rule, such wounds are the most likely to recover without peritonitis, and, except in the case of gunshot wounds, without fistula. In gunshot wounds, unattended at the time by effusion, a fistula may subsequently be formed by the separation of sloughs, after the adhesion of the stomach to the parietes. Effusion is sometimes prevented, though the opening be large, if the wound passes obliquely through the different coats of the stomach; and immediate and incessant vomiting, by clearing the stomach of all its contents, sometimes obviates their escape through the wound. It has occasionally happened that a small amount of material has escaped through the opening in the stomach, and, having been circumscribed by inflammatory adhesions, has afterwards been discharged externally by means of suppuration.

When the contents of the stomach escape through the external wound, there is the clearest possible evidence of the nature of the injury. Such a

¹ Op. cit., pp. 75, 76.

² Cours d'Opérations de Chirurgie, revue par G. de La Faye, p. 84. 1751.

³ Bleedings practised one after another, absolute diet, and emollient fomentations on the belly, are almost the only resources of our art, whether to prevent these symptoms or to remedy them.]

case is less favorable than those in which there is no effusion at all, but very much more favorable than those in which the escape is into the abdominal cavity. Whatever is taken by the mouth may be discharged almost at once, and almost unaltered, through the wound. Peritonitis, more or less severe and more or less general, may arise, and a fistula, for a time at least, is pretty certain to follow.

When the contents of the stomach escape into the abdominal cavity, there will be the same urgent symptoms as attend extravasation of feces, bile, or urine. The chief diagnostic symptoms of these hopeless cases, according to Travers, appear to be:—

(1) Sudden, most acute, and unremitting pain, radiating from the scrobiculus cordis, or the navel, to the circumference of the trunk, and even to the limbs. A peculiar pain, the intensity of which, like that of parturition, absorbs the whole mind of the patient, who, within an hour from the enjoyment of perfect health, expresses his serious and decided conviction, that if the pain be not speedily alleviated he must die.

(2) Coeval with the attack of pain, remarkable rigidity and hardness of the belly, from a fixed and spastic contraction of the abdominal muscles.

(3) A natural pulse for some hours, until the symptoms are merged in those of acute peritonitis, and its fatal termination in the adhesive stage.¹

There are, besides, extreme anxiety, collapse, cold sweats, and what John Hunter has described as a “sleepy languidness in the eye, which makes one suspect something more than a common wound.”

In every form of stomach-wound there may be vomiting of blood, and blood may also escape through the external wound.

Diagnosis.—The situation of the wound, the vomiting of blood, and especially the escape of chyme, or fluids, or particles of food recently taken, are the indications of wound of the stomach. When we have only the first of these three means of judging, the diagnosis must be uncertain.

Prognosis.—As Hennen has observed, these cases are extremely dangerous, though not always mortal. Punctured and small incised wounds are *cateris paribus*, the most hopeful; lacerated and gunshot wounds the most fatal. Alcock gives only one case of recovery from wound of the stomach out of 3000 cases of gunshot wound. Wounds near or at the curvatures are attended by more danger from hemorrhage than wounds on the surfaces; and hemorrhage is here very difficult to stop. Recoveries after wounds of the stomach are recorded by Thomson, Guthrie, Hévin,² William Scott³, Archer, and McCarterat; and Abernethy relates a case in which, after a gunshot wound of the stomach, adhesions were formed, the stomach sloughed, and its contents were received into a pouch which gradually extended till it broke at the groin. The fluids which were taken by the mouth could be drawn off through the resulting fistula, by simply removing a little cork, which the patient, a Frenchman, was in the habit of wearing in the opening, and removing for the purposes of public exhibition.

The results of wounds of the stomach which are not fatal, are (1) adhesion of the wound in the stomach to the peritoneum of the parietes, or of some other organ, and the closure of the wound in the abdominal walls; (2) formation of a fistulous opening, which may remain permanent for the rest of life, or may close after an interval varying from a few days to 27 years (Wencker's case).

Treatment.—Total abstinence from all food and drink, for a time; enemata of beef-tea and egg, with or without opium, as required; the utmost quietude; and the relaxation of the abdominal muscles by position, are the best means

¹ Med.-Chir. Trans., vol. viii. pp. 231 *et seq.*

² Mém. de l'Académie de Chirurgie.

³ Med. Communications, vol. ii. p. 78.

for guarding against extravasation. If extravasation have not already occurred, the external wound should be closed by sutures; and in certain cases, before doing so, it will be possible to see the wounded viscus, and to draw it out through a large wound, stitch up the opening in it, and return it. Percy and M. Rubstral did this successfully. In exceptional cases it would be justifiable to enlarge the wound in the parietes for this purpose. When inflammation sets in, the treatment should be that recommended for traumatic peritonitis.

Penetrating Wounds of the Intestine.—The symptoms of wounded intestine are commonly more severe, and extravasation more frequent, in lesions of the small than in those of the large bowel. This is owing to the more delicate organization of the small bowel, to its more fluid contents, to its nearer situation to the stomach and the point of entrance of such important secretions as the bile and pancreatic fluid, and to the fact that when the effusion takes place from an opening high up in the small bowel, even though the escape is entirely external, death must ensue from marasmus. The close connection of the duodenum and upper end of the jejunum with the sympathetic ganglia and nerves, probably explains why wounds of these parts of the gut are so commonly attended with extreme anxiety and shock.

Symptoms.—The severity of the general symptoms is not by any means always a measure of the extent of the injury, or of the gravity of the case. It is the same in injuries of the abdomen as in those of other regions: some persons suffer much more severely, and reaction in them is much longer delayed than in others. As a general statement, however, the danger of the case will depend, first, upon the occurrence or non-occurrence of extravasation of the intestinal contents into the abdominal cavity, and this again will depend greatly upon the size and character of the wound, a point to which reference has already been fully made; secondly, upon the persistence of vomiting, which is an unfavorable condition, and one which, unless it can be controlled, is sure to lead to a fatal end; thirdly, upon hemorrhage; and fourthly, upon the character of the supervening peritonitis. When there is no escape of chyle, feces, or fecal gas, through the external wound, both the local and general symptoms are equivocal. Perhaps the most characteristic signs are the peculiar griping pains in the abdomen, the urgent thirst, the desire for cool air, the nausea and vomiting, the bloody stools, and the tympanites. Dr. Gross lays great stress on this latter symptom, which he thinks has not been sufficiently insisted upon by systematic writers, and which, from being often present when the other symptoms are absent, may be regarded in some degree as pathognomonic. Jobert, too, thinks it the most valuable and positive sign of a wound of the intestine that we can have, except of course the egress of intestinal contents. Both Dr. Gross and Jobert relate several instances in which the diagnosis was made by this symptom alone. The tympanites occurs from a few minutes to several hours after the accident, and is always accompanied with tenderness on pressure and difficult respiration. I can myself testify to the importance of this symptom as indicating the giving way of the bowel, especially of the cæcum or large intestine, in cases of intestinal obstruction; but at the same time it is often a most prominent symptom in acute peritonitis where the intestine is unruptured, and it may also arise as a consequence of simple contusion, from intestinal palsy following on concussion of the ganglionic nerve-centres. Neither is tympanites an accompaniment of all traumatic injuries of the intestine, for, as Dr. Gross remarks, it does not take place if the opening is very small, and if effusion is prevented by the protrusion of the mucous membrane, or otherwise. The discharge of blood by the anus or by the mouth will vary according to the part

of the intestine wounded. The quantity discharged sometimes amounts to many ounces, or even pints, and its color depends upon the length of time it has been retained in the bowel. It may begin to pass off at once, or not until seven or more hours after the accident; and it may continue to pass for some days. It must be borne in mind, however, that the discharge of blood from the intestine attends other injuries than actual wound of the bowel. Rarely, after gunshot wounds, the bullet has been passed off by the stools. M. Chenu has recorded one such instance. In almost every case there is nausea, with or without vomiting, beginning within a few minutes of the injury; these symptoms persist sometimes for days, with great obstinacy, even until death comes to the relief of the sufferer. The pain is generally of a gripping character, but it may be of a dull, aching kind; it is almost always aggravated by coughing, or by a deep inspiration, or even by the pressure of the bedclothes.

If there be extravasation of the contents of the bowel into the peritoneum, death will certainly occur, unless the amount extravasated be very small, and escape so slowly as to allow of its being inclosed by plastic lymph. Sometimes death takes place in cases of extravasation within a few hours from the first shock of the accident. More commonly it is caused by acute peritonitis, the symptoms of which do not usually extend over forty-eight hours; they need not be here recapitulated. If the extravasated matter has become encysted, an abscess generally forms and is evacuated, or the patient, after weeks or months of suffering, is worn out by chronic peritonitis or exhausting discharges.

If there be extravasation through the external wound, the adhesive process may, in a few hours, seal the edges of the intestinal to those of the parietal wound, and the peritoneal cavity may thus become closed. Much temporary relief is obtained by this external escape of the intestinal contents: abdominal tension is taken off; inflammation is lessened, and after a few days, under favorable circumstances, subsides altogether; the wound granulates; and if the intestine can resume its natural function, and the part injured be not too near the stomach, life is preserved, and that, too, without the complication of a false anus or fecal fistula. External effusion is, however, prevented by the obliquity of the wound in the different layers of the abdominal parietes, by the intestinal wound not being opposite to the parietal wound, or by the partial closure from muscular contraction of the parietal wound. The passage of the contents of the large bowel through the external wound is more easy than that of the contents of the small gut, owing to the greater fixity of the large intestine.

Diagnosis.—This lesion ought to be suspected if nausea and vomiting, accompanied with faintness, great restlessness, extreme anxiety, cold sweats, colicky pains, and tympanites, follow immediately or soon after a penetrating wound of the belly. The suspicion is confirmed if, some time after the setting in of these symptoms, blood is vomited or passed by the rectum. If there is escape of the contents of the intestine through the external wound, the diagnosis is of course positive.

Prognosis.—Though essentially dangerous, these wounds are not necessarily fatal; and no absolute rule can be formulated in respect to their prognosis, except that they must always be regarded as amongst the gravest accidents, and likely to be followed by the worst results. That some persons die from the shock of even a small wound, whilst others recover from the most desperate injuries to the abdominal contents, has been already stated, and is well known to surgeons. It is possible that in some penetrating wounds, as in some cases of blow upon the epigastrium, death is produced by the mere shock to the sympathetic nervous system. On the other hand, the abdomen

may be transfixcd through and through, and the viscera wounded at many points, and no bad consequences follow. Every work on wounds of the intestine contains the records of one or more such cases. If effusion occurs into the peritoneal cavity, the prognosis is certain death, except under the condition of slight and slow extravasation. If the effusion is external, death may occur from peritonitis or marasmus; or recovery may follow with or without a fecal fistula or false anus. Diffuse peritonitis, once established, is fatal; circumscribed peritonitis, when localized in the immediate seat of the wound, is often protective only, not destructive. Whether there be effusion of intestinal contents or not, hemorrhage may occur into the peritoneal cavity, and death may follow in a short time from the loss of blood, or from peritonitis caused by the clotted blood acting as a foreign body; or the clot may be absorbed or become encysted, and the patient recover.

Treatment.—Where no extravasation whatever occurs, the case must be treated as one of simple penetrating wound of the parietes. If feces escape, the wound must be left open, and in as dependent a position as possible. Entire rest, and abstinence from food, from purgatives, and from all forms of drink, must be enforced. Thirst must be slaked by small fragments of ice, or by submerging the patient in the continuous warm bath. Opium or morphia must be given, either by the rectum or as a subcutaneous injection, to allay pain and check peristaltic action. It is still an open and unsettled question whether it is proper to enlarge the wound with the object of applying sutures to the wounded bowel. If effusion has not taken place, and the visceral wound is small, such a step could but add to the danger by the disturbance necessitated by the search for the wound, which might be unsuccessful in the end. If effusion has taken place some time before the patient is seen, inflammation will probably have set in, and the parts will have become glued together, or will have passed beyond the reach of repair. Again, after transfixion of the belly, if the viscera are wounded in several places, interference is hopeless, if not mischievous. But when there is clear or good presumptive evidence of extravasation, from a single or at most a double wound—or if the wound in the intestine can be seen through the external opening—there can be no question that the wisest plan is to close the visceral wound by suture.

Dr. Otis¹ remarks:—

“That enterorrhaphy is the proper treatment for punctured or incised wounds of the intestines, with protrusion, is now questioned by none; that in similar wounds, without protrusion of the small intestine, and of parts of the large intestine covered by the peritoneum, it is proper to enlarge the external wound and find the wounded part, and secure it by enterorrhaphy, a mass of affirmative evidence has been brought forward. The experience of the war does not enable us to demonstrate the benefits of applying the same principles to shot-wounds;” but he adds (p. 128), “already interference contrasts favorably with the do-nothing system. Reflection . . . leads unavoidably, in the writer’s opinion, to a conviction of the propriety of incising the abdominal wall when necessary, in order to expose and sew up the wounded gut concealed within the cavity, whether divided by a cutting instrument or by shot. The obstacles to success are obvious; but it is a mortal peril which demands an extreme remedy.”

Should peritonitis occur, the treatment appropriate for that complication must be followed.

Gunshot wounds of the stomach and intestine are not necessarily attended with effusion into the abdomen, nor externally through the wound. When effusion does occur, it may be either primary, or secondary, owing to the separation of the sloughs along the track of the bullet. The period of the

¹ Med. and Surg. Hist., etc., Part II., Surg. Vol., p. 124.

separation of these sloughs may be at any time from the eighth to the fourteenth day. The great difference between primary and secondary effusion, is that the primary is generally into the cavity of the abdomen, whereas the secondary extravasation is very commonly at the external wound, adhesive inflammation having sealed the peritoneal cavity from the wounded part of the viscus, and the wounded viscera to one another. In this way, if two or more coils of intestine have been penetrated by the shot, they become united to one another around about the wounds, and if sloughs subsequently separate, they fall into the interior of the bowel and are passed off with the stools. As John Hunter says, in describing the case of a young man who recovered without an artificial anus, after being shot through the abdomen by three balls:—

I concluded that whatever cavities the balls had entered, there the surrounding parts had adhered, so that the passage of the ball was by this means become a complete canal, and therefore that neither any extraneous bodies that had been carried in with the balls and had not been carried through, nor any sloughs that might separate from the sides of the canal, nor the matter formed in it, could now [about a fortnight after the infliction of the wound] get into the cavity of the abdomen, but must be conducted to the external surface of the body, either through the wounds, or from an abscess forming for itself, which would work its own exit somewhere. But this conclusion was supposed to be too hasty, and soon after a new symptom arose which alarmed those who did not see the propriety of my reasoning, which was some feces coming through the wound; this new symptom did not alter my opinion respecting the whole operations of nature to secure the cavity of the abdomen, but as I saw the possibility of the wound becoming an artificial anus, I was sorry for it.

Penetrating gunshot wounds of the abdomen are for the most part fatal. Alecock says that of 18 cases in the Prussian war, between 1836 and 1837, all ended in death; and Poland states that during the revolution of Paris, in July, 1848, there were a great number of such wounds, and for the most part fatal. Matthew records that in the British army in the Crimea—

Where penetration of the abdominal cavity by gunshot injury was considered to be beyond doubt, death was the rule, recovery the rare exception, only nine patients having survived out of 120 where this was believed to have taken place, and even of this small number some of the cases were not unequivocal.

M. Chenu states that, in the French army in the same war, out of 121 penetrating shot wounds of the abdomen 111 died; and as regards the Italian campaign in 1859, he says, “penetrating wounds, very grave usually, gave a great mortality in the field, and an equally great mortality in the hospitals.”

Writing of *wounds of the viscera within the peritoneal cavity* during the American War of the Rebellion, Dr. Otis says that “he has sought to analyze the different varieties of this group, and to estimate the comparative mortality of wounds of the liver, spleen, and kidneys, and of the alimentary canal; and it is believed that those who will take the trouble to examine the evidence, will be unable to resist the conclusion that, while recoveries from wounds of the liver are more frequent than was formerly believed, and wounds of the spleen and kidney occasionally, and those of the colon frequently, terminate favorably, the rarity of recoveries from wounds of the stomach and small intestine treated without operative interference is extreme.”¹

In the numerical statement of the cases of penetrating wound of the abdomen during the American War (Table IV.), out of 79 cases of gunshot wound of the stomach, 19 ended in recovery; and of 653 cases of gunshot wound of the intestine, 118 ended in recovery, and in 51 the results were unknown. But of these cases of recovery after wounds of intestines, the largest group

¹ Med. and Surg. History of War of Rebellion. Part II., Surgical Volume, p. 205.

includes cases of perforation of the large intestine *in parts uncovered by peritoneum*, and there are only 5 cases of recovery after gunshot wounds of the small intestine.

Dr. Otis tells us that musket-balls commonly divide a considerable portion of the calibre of a small intestine; carbine or pistol-balls sometimes make two perforations of its walls; and occasionally a small projectile may perforate the intestinal wall at a single point, and lodge within the gut. In such cases as the last mentioned, the usual eversion of the mucous tunic ensues, and the appearances are not to be distinguished from those resulting in a true punctured wound, inflicted by a sharp-pointed instrument. He also considers it to be characteristic of shot-lesions of the intestines, that the injury to the serous, is less extensive than that to the mucous and muscular tunics. Though a ball completely traversing the abdomen has been known to wound the small intestine no less than sixteen times in its passage, it is not, Otis thinks, very common for more than two convolutions to be wounded, or for the wall of the small intestine to be perforated in more than four places. Dr. Gross¹ records a case in which a pistol ball perforated the ileum, jejunum, duodenum, and arch of the colon, making thus eight separate orifices; and many other such cases of multiple injury are on record.

In the treatment of penetrating wounds of the abdomen, as has been stated above, much difference of opinion has been expressed respecting the propriety of abdominal incision for the removal of extravasated matter and the application of sutures to the intestine, or, in other words, the practice of enterorrhaphy. It seems to me, however, that sufficient distinction is not always made by writers between ordinary incised or punctured wounds on the one hand, in which it is probable that the intestine is wounded at only one or at most two points; and cases of gunshot or other contused wounds on the other hand, in which it is almost certain that more or less sloughing must follow about the edges of the wound, and in which the intestines are wounded in several points which would have to be sought for at the risk of dangerous and prolonged disturbance and manipulation, and some of which, in all probability, would be overlooked by the eye of the surgeon, though the officious inquisitiveness of his fingers might cause them to become the seat of effusion. Poland, with the evidence before him of that brilliant epoch in military surgery when Larrey, Hennen, and Guthrie, were the guiding lights, condemned the practice and recommendations of Baudens and Legouest; Neudörfer and F. H. Hamilton have more recently condemned any surgical interference with shot-wounds of the intestines; and after a careful perusal of the marvellously full and exhaustive chapter on Injuries of the Abdomen in the Medical and Surgical History of the War of the Rebellion, in which enterorrhaphy is advocated, I entirely coincide with the opinion of that revered and veteran master of surgery, Prof. Gross, who, while heartily endorsing the propriety of exploratory incision and of enterorrhaphy in cases of ordinary intestinal wounds without protrusion, regards such measures as unlikely to be of benefit in shot-wounds of the bowels, because such lesions are commonly multiple, and, I would add, always of the nature of contused wounds.

The experience of the American War affords nothing in proof of the benefits of laparotomy and enterorrhaphy in gunshot wounds, and the inference is, that what Thomson² wrote after the battle of Waterloo, might be equally said of the surgeons engaged in that war: "In these cases, the more that is left to nature in the process of reunion, and the less her operations are interfered

¹ System of Surgery, vol. ii.

² Report of Observations made in the British Military Hospitals in Belgium, etc., p. 106. Edinburgh, 1816.

with, the greater will be the chance of ultimate recovery." I would, however, advise the reader to peruse for himself Dr. Otis's very exhaustive and masterly summary of the subject.¹

Penetrating Wounds of the Liver.—Punctured and incised wounds of the liver are much less frequent than subcutaneous ruptures of that organ. In the annals of Surgery about sixty cases of stab-wound of the liver are definitely described, and Ludwig Mayer has collected twenty-one instances of recovery from such injuries. They rarely come under the notice of the surgeon. The surgeon, however, occasionally inflicts such wounds upon his patients, as in the treatment of hydatid cysts and abscesses of the liver. Hemorrhage is one of the chief dangers, but there is good reason for thinking that in the case of clean incised wounds it is controllable, and has been overrated. Slight and superficial wounds are followed by recovery, but when deep, and if attended by any large amount of hemorrhage into the abdominal cavity, they are speedily fatal.

Symptoms.—These are hemorrhage, and perhaps a discharge of bilious matter from the wound—or evidence of internal hemorrhage—accompanied by a dull pain, which, according to Boyer, extends to the shoulder and larynx if the convex surface be wounded, and an acute pain about the ensiform cartilage if the under surface be injured; vomiting, hiccough, and labored breathing; followed by occasional rigors, tympanites, heartburn, and, at a still later period, by more or less delirium. If the patient survives many hours, the functions of the stomach and bowels are disturbed; and if general hepatitis occurs, jaundice of the skin and bile-pigmented urine appear, and great itching of the surface will follow.

Diagnosis.—The position and direction of the wound will greatly assist in arriving at a correct diagnosis. If the weapon have entered between the lower intercostal spaces of the right side, the liver must be involved, unless the wound be limited to the parietes; and if the wound be below the ribs and its course horizontal, the liver may be implicated, as the organ may extend to a very low position on the right, owing either to enlargement or displacement.

The prognosis is very unfavorable if the wound be a severe one; as has been stated, slight wounds are often recovered from.

The treatment does not differ from that described for rupture of the liver; the wound of the parietes adds but little to the danger, and in comparison with the visceral injury is unimportant. If the external wound be large, it should be held together by sutures; but if bile or blood be escaping through it, it must be kept open. Should peritonitis occur, it must be treated as already described.

Gunshot wounds of the liver vary from slight groovings, or laceration of the peritoneal investment only, to long perforations and lacerations complicated with the presence of splinters of ribs, or fragments of clothing, or other foreign bodies; from slight fissures or limited contusions, to extensively pulped or mangled ruptures. These differences depend greatly upon the velocity of the projectile, as well as upon its size and direction. At close ranges, the missile inflicts great destruction, and mangling appears to be the all but uniform effect of even small carbine or pistol shots upon the liver. (Otis.) The first dangers of these wounds are shock and primary hemorrhage, and if the patient escapes these, he will be likely to die of secondary hemorrhage, peritonitis, or abscess of the liver. Such injuries, however, even when very serious, are not necessarily fatal. Dr. Otis records 25 recoveries

¹ Med. and Surg. History of the War of the Rebellion. Part Second, Surgical Volume, pp. 123–128.

out of 59 cases of gunshot wound of the liver, uncomplicated with lesions of other organs; and 37 recoveries out of 111 cases of shot-wound of the liver complicated by various grave injuries either of the abdomen or other regions. Wounds of the liver are very frequently associated with fractures of the lower ribs and spine, and with wounds of the diaphragm and other viscera at the upper part of the abdomen. General hepatitis, demonstrated after death as well as clinically, was present in only a small proportion of the cases which occurred in the war of the Rebellion. As in gunshot wounds of the lung, general pleurisy and pneumonia are the exceptional, not the usual consequences, the inflammatory changes being as a rule limited to the immediate vicinity of the bullet track; so in the case of shot-wounds of the liver, inflammation is localized, and partial hepatitis the result. Jaundice, though a constant symptom of general hepatitis, is rarely present in inflammation of small areas of the liver.

Penetrating wounds of the gall-bladder and ducts are extremely rare on account of the small size and protected situation of those organs. They are very fatal on account of the irritating action of the bile upon the peritoneum, over which it diffuses itself rapidly. John Bell,¹ after speaking of wounds of the bladder, says: "The wound of the gall-bladder is like this; for its fluid is stimulating in a still higher degree, and the patient very seldom escapes the quick and deadly inflammation; the urine and the bile act like poisons thrown into the abdomen, the patient dying a most miserable death." Again, he says: "The bile is the highest stimulus, the urine next, the food and the feces are less irritating, and the blood least of all; perhaps it is according to this order that the danger of these wounds should be calculated, effusions of bile being the most dangerous."² That the intensity of peritonitis from effusion of bile has been exaggerated, is shown by the experiments on animals of Höring,³ Herlin,⁴ and Campaignac,⁵ and by some of the recorded cases of extravasation of bile in the human subject. Bohn, in 1689, and Kaltschmidt, in 1735, held that bile might be effused into the abdomen without any immediate danger, but a century later, Sabatier, who had an opportunity of noticing the symptoms in a case of wound of the gall-bladder, regarded fatal peritonitis, after a few hours or days, as the necessary result of extravasation of bile into the abdominal cavity. Sabatier's view is still the prevailing one, but it requires modification, both as to the intensity of the inflammation and the rapidity of its course.

Symptoms.—These are great abdominal tension and pain, especially in the right hypochondrium, with small, frequent, contracted and intermittent pulse, difficult respiration, sleeplessness and great restlessness, cold extremities and pinched, pale countenance, and sometimes jaundice, hiccough, and nausea. Dr. Stewart⁶ communicated to the Royal Society, of London, a case of wound penetrating the abdomen and fundus of the gall-bladder, without doing any material injury to the adjacent parts:—

The abdomen was immediately distended to an extreme degree, and the amount of tympanites did not afterwards diminish. There was complete constipation in spite of purgatives and clysters. A good deal of liquid nourishment was given; anodynes failed to procure a moment of sleep, and there was incessant restlessness till the patient's

¹ Op. cit., p. 356.

² Ibid., p. 358.

³ Diss. sistens experiment. de mutationibus quas materiæ in cavum peritonei injectæ subeunt. Tübing., 1817.

⁴ Journ. de Méd., t. xxvii. p. 463.

⁵ Journ. Hebdom., t. ii. p. 210.

⁶ Philosophical Transactions, No. 414, p. 341.

death, which happened in a week. After death the intestines were found much distended, the gall-bladder quite empty, and a large quantity of bile extravasated.

Sabatier's¹ case was very similar to Dr. Stewart's:—

The patient died on the third day, a few hours after a blackish-green, odorless fluid, supposed to be pure bile, had been drawn off through a canula, introduced into the right iliac region. On opening the body, the bowels were found prodigiously distended, and the gall-bladder shrivelled and almost empty; in its fundus was a wound about a line and a half long, corresponding to a similar wound in the peritoneum. The instrument had penetrated between the third and fourth false ribs, and had glided from above, downwards and forwards between the cartilages of the ribs, until it had reached the fundus of the gall-bladder.

Watson² gives a fatal case from puncture of the cyst by a bayonet; and Sir Astley Cooper gives another, in which the bayonet entered just below the margin of the ribs, on the right side; the wounded man fainted and fell, and on recovering consciousness experienced agonizing pain in his abdomen, which became extremely tense and tender, and he died in thirteen hours. The gall-bladder was found to have been penetrated, and bile was extravasated into the abdomen; and wherever it had rested the peritoneum was highly inflamed.

Wounds of the hepatic, or cystic, or common duct, would doubtless be attended with the same symptoms as wounds of the gall-bladder, but they must be extremely rare. I do not know of any case on record of penetrating wound of the ducts, except from gunshot. In a case of gunshot perforation of the right lobe of the liver, with division of a branch of the hepatic duct,³ bile was discharged at intervals from the wound, and the man died of general peritonitis, with adhesions, on the forty-fourth day.

In cases in which the gall-bladder has been wounded by gunshot, the liver has been injured too. In one instance⁴ the ball passed through the cartilage of the ninth rib, the quadrate lobe of the liver, the gall-bladder, ascending colon, and right kidney, and made its exit near the twelfth dorsal vertebra; the shock was not severe, but in a few hours there were great pain and tension of the abdomen, and death occurred in fifteen hours from the time of the injury. The peritoneum was found filled with blood, and intense peritonitis had already been established. In two other cases,⁵ in which both liver and gall-bladder were injured, the patients lived five and eight weeks respectively. In both there was discharge of bile from the wound; in one there was jaundice of the skin and conjunctiva, and in the other severe diarrhœa existed for the whole five weeks of life. This last symptom is noteworthy, as obstinate constipation is mentioned by Poland and others as a symptom of injured gall-bladder.

Prognosis.—The only known instance of recovery after gunshot wound of the gall-bladder, is the case recorded by Parroisse,⁶ as having occurred to M. Huttier. It was that of a military man, who received a shot-wound in the internal and lateral part of the right hypochondrium, and who died two years subsequently of chest-disease, when a ball was found in the gall-bladder, on which, however, there was no trace of a cicatrix.

Treatment.—These injuries must be treated like other penetrating wounds of the abdomen with lesion of the viscera. There are reasonable grounds for thinking that in wounds, as in ruptures, of the gall-bladder, it is probably

¹ Médecine Opératoire, tome i. p. 43. Paris, 1796.

² Journal de Méd. Milit., tome vii. p. 550.

³ Med. and Surg. History of the War of the Rebellion, Part Second, Surgical Volume, p. 139.

⁴ Ibid., p. 136.

⁵ Ibid., pp. 136, 137.

⁶ Opusculs de Chirurgie, p. 254. 1806.

not as much the original escape of bile which brings about the fatal result, as its continual filtration into the peritoneal sac; hence the question arises, as Campaignac pointed out, how far surgery can afford any aid in preventing the further escape of bile in this kind of injury. To this end he advised ligation of the ducts, and Herlin, removal of the gall-bladder.¹ If it happened that the cyst or one of the ducts alone were injured, laparotomy, followed by the stitching up of the wound in the cyst or the ligation of the duct, might be followed by a good result, and would be certainly worthy of trial, especially as these injuries are so commonly fatal. But if the liver also were wounded, and some large branch of the bile-ducts within it laid open—or if, as in the case above referred to, several other important viscera were wounded also—no good could possibly follow from such an operation.

Penetrating Wounds of the Spleen.—The spleen is less liable to penetrating wounds than the liver, owing to its smaller size; and wounds of the liver and stomach, but more especially of the thorax and diaphragm, and left kidney, are commonly met with as complications. The situation of the spleen exposes it more readily to penetrating wounds from the side and back; but when injured from the front, some of the viscera in front of it are nearly sure to be implicated. Larrey remarked that left-handed persons, in armed encounters, were most exposed to wounds of the spleen, because they presented the left side uncovered, and towards this the aim of the adversary was naturally directed.

The *symptoms* are those indicative of severe internal hemorrhage, with great tension and distension of the abdomen. The blood gravitates towards the pelvis, and may be poured out in such quantity as to give a sense of fluctuation in the abdomen. If hemorrhage is not very extensive, peritonitis sets in sooner or later, and probably carries off the patient; or localized splenitis and abscess supervene, more especially if foreign matters, such as pieces of dress, have been carried in and remain.

In Sir A. Cooper's case of a man stabbed by a dirk, the abdominal cavity was filled with fluid blood, and in the case of fatal bayonet wound recorded by Otis,² the abdominal cavity was full of clotted blood.

Diagnosis.—Wounds of the spleen present no distinctive symptoms, and are to be recognized only by the site of the wound, and by the supervention of faintness, coldness, and pallor, denoting internal hemorrhage, with the absence of those signs which indicate wounds of the contiguous viscera. Hunter³ remarked: "A wound of the spleen will produce no symptoms that I know of, excepting probably sickness, from its connection with the nerves of the stomach." Nor was Dupuytren⁴ able to afford any additional light on the subject.

Prognosis.—The older surgeons considered wounds of the spleen and liver, like those of the vena cava, as deadly as wounds of the heart, "so full of blood were they,"⁵ though John Bell was perfectly aware that patients had recovered "where the liver must have been wounded more or less."⁶ But modern instances of successful removal of parts of the spleen in man, and cases such as those recorded by Klebs and Albanese, prepare us for the conclusion that wounds of the spleen are less fatal than was formerly supposed. Hennen says: "Of wounds of the spleen I have seen a few; some of the slighter

¹ M. L'Anglas repeated M. Herlin's experiments on two dogs, and extirpated the gall-bladder after tying its neck. These two dogs recovered.

² Med. and Surg. History, etc., Part Second, Surgical Volume, p. 150.

³ Treatise on the Blood, Inflammation, and Gunshot Wounds, p. 545.

⁴ Leçons Orales, t. vi. p. 430.

⁵ Bell, op. cit., 3d ed., p. 351.

⁶ Ibid., p. 354.

recovered, the deep invariably proved fatal." Guthrie remarks: "I have seen cases of wounds from stabs and from musket-balls, which ought to have injured the spleen, from which the sufferers recovered; and I have accidentally seen, after death, cicatrices formed in the spleen, corresponding to the external marks indicative of a former wound."

Larrey saw three cases of wound of the spleen by steel weapons, all of which ended in recovery; Leveille, an instance of severe sabre wound of the spleen, which ended in recovery after intense peritonitis and prolonged suppuration. Recovery after a lacerated wound of the spleen and other abdominal injuries in a shepherd boy, aged eleven, is reported by M. Sappey.¹ Other cases of recovery after penetrating wounds of the spleen have been collected by Otis.² M. Legouest holds the now generally accepted view that though hemorrhage and peritonitis frequently cause death, yet recovery follows some severe splenic injuries.

Gunshot wounds of the spleen, if of a minor degree, are often repaired, and sometimes not suspected; and even extensive injuries, associated with loss of substance, are not necessarily fatal, or followed by any apparent change in the blood-making functions. Recovery may occur, though part of the bullet remain behind in the organ, as is proved by the case of the patient who died at Guy's Hospital, from Bright's disease, four years after a shot wound of the colon. At the autopsy, a piece of the bullet was found in the spleen.

Treatment.—The first indication is to check hemorrhage, the next to allay peritonitis. With the first object in view, the injured side should be strapped, as for fractured ribs, and the patient should then lie upon it. Iced drinks and ergot should be freely given, and cold should be applied externally. If peritonitis supervene, it should be met as in cases of traumatic inflammation of the peritoneum. Excision of the spleen, in some cases—in those especially in which the bleeding continues, or a large part of the organ is contused or nearly broken off—may afford the best prospect of recovery. There is no reason why splenectomy for traumatic destruction of the spleen should not be put on trial; the great mortality of the operation, hitherto, largely depends on its having been performed almost exclusively in cases of leucocythæmia or of other morbid general conditions.

Wounds of the pancreas and thoracic duct are not likely to be diagnosed, and the only interest attaching to them is this, that nearly everything about them has yet to be discovered. Beyond knowing that a portion of the pancreas may be torn from the splenic artery and its other attachments, and protrude through an external wound, and, under such circumstances, may be removed without serious consequences, we know nothing except this, that after wounds of the pancreas, death, as a rule, occurs from shock and peritonitis combined, or else from secondary hemorrhage; that life has been prolonged for twelve days or more; and that the lesions have occurred without being suspected.

John Bell's strictures on his namesake's (Benjamin Bell's) comments on wounds of the pancreas and receptaculum chyli, as on many other subjects, are well known to the student of surgical literature; and here, as elsewhere, they are based quite as much upon conjecture, instead of experience of the special matter in question, as the remarks he so vigorously attempts to refute. In justice to Benjamin Bell, it should be noticed that he says, "any injury done to the pancreas can seldom be discovered;" and if actual experience has not proved him right in supposing that division of the duct of the gland will interrupt digestion, or that the chyle or pancreatic fluid will form

¹ L'Union Médicale, n. s., t. xxi. pp. 408, 469. 1864.

² Op. cit., Part Second, Surgical Volume, p. 150.

collections in the abdomen "the removal of which may ultimately require the assistance of surgery,"¹ it has at least, to judge by recorded cases, shown John Bell to have conjectured wrongly when he said that the pancreas could not be hurt "without a most complicated and absolutely fatal wound."² Otis has collected three cases of recovery from stab-wound followed by protrusion and removal of a portion of the pancreas, and gives brief notes of another case of recovery after shot-wound, under the care of Surgeon J. G. Thompson, during the War of the American Rebellion. The most interesting, and apparently the best authenticated case, is that of Caldwell.³ In 1816, a negro man was stabbed in the left side, and "an oblong body, between three and four inches in length, was observed to be protruded between the last true and the first false rib." Being in a gangrenous state, it was removed by the bistoury, and the patient soon recovered, and was living and quite well eleven years after, "having suffered no inconvenience from the loss of the part or its unnatural adhesions." Drs. Roberts, Heard, and Caldwell made a critical examination of the part removed, and were convinced that the mass cut away was a portion of the pancreas.

In Thompson's case, the ball entered below the ribs on the right side and emerged on the left, and two days afterwards, while the patient was straining at stool, a hernia of the pancreas, as large as a hen's egg, occurred. The projecting mass was ligatured with silver wire, and cut away with scissors. The patient was convalescent in two months.

Some authors have asserted that, after an injury to the pancreas, there might be an effusion of colorless liquid, as a characteristic symptom of the lesion; and that after wounds of the thoracic duct, clear lymph, when digestion had not been going on, and a milky fluid after a meal, might escape from the external wound; but I am not aware that such an occurrence has ever been observed.

Penetrating wounds of the kidney have been described by almost all systematic writers, and a special dissertation on them was published by Gittler, at Leipzig, as far back as 1596. They present many differences, according as they affect the cortex only, or penetrate to the tubular and pelvic portions of the organ, and as they do or do not involve the peritoneum, or large bloodvessels of the kidney. From its anatomical position, wounds of the kidney, like sub-parietal ruptures, may be of two chief classes: (1) Those inflicted upon the posterior surface, and in which the peritoneum is not involved; (2) those affecting the front surface, and in which the peritoneal cavity is necessarily perforated, and very probably some of the other viscera are injured as well.

Symptoms.—The symptoms of a wound of the kidney will vary according to the situation and depth of the wound. If superficial, so that it involves the cortical structure only, blood and urine will escape at the external wound, or into the abdominal cavity, according to the situation of the injury. If the wound be deep, and the tubular structure or calyces are reached, blood will almost certainly be passed by the urethra, and clots are likely to accumulate in the bladder, though urine and blood may also escape into the surrounding parts. The injury is generally followed by great pain in the lumbar region, pain and spasmodic retraction of the testicle, nausea and vomiting, dysuria, muscular spasm or rigidity, and afterwards by nephritis, protracted suppuration, or more or less peritonitis. If the peritoneum is involved, and urine is extravasated into its cavity, fatal peritonitis must be expected. When the injury to the

¹ System of Surgery, vol. ii. p. 147.

² Op. cit., 3d ed., p. 366.

³ Transylvania Journ. of Med., vol i. p. 116. 1828.

kidney is associated with wounds of the stomach, liver, spleen, or other important part, such as the intestines, diaphragm, or spine, a speedy death from shock, or shock and hemorrhage combined, is very probable. If the wound is outside the peritoneum, there may form, after several days, a dull swelling in the renal region, due to retro-peritoneal accumulation of urine, or of urine and blood. Diffused urinous infiltration into the cellular tissue of the loin is not a common occurrence. When hæmaturia occurs, it may come on at any time from a few minutes to a few days, though it usually sets in after a few hours; it may last for only a day or two, or extend over several days; it may be slight and merely sufficient to stain the urine, or it may be profuse and even fatal. Retention of urine, which has been known to last for four, five, or six days, and then to be followed by the passage of bloody urine and clots, has in some cases of punctured wound been a striking feature. In two gunshot cases, pieces of cloth from the soldiers' uniforms—in one instance accompanied by epithelial detritus, and in the other coated with phosphates—were passed by the urethra. Probably the most singular case on record, as illustrating nearly the whole series of symptoms of injuries of the kidney, is that recorded by Hennen:—¹

An officer was wounded by a musket-ball which entered close to the interval of the ninth and tenth ribs, about midway between the sternum and spine, and was cut out from near to the point of the transverse process of the lowermost dorsal vertebra, on the day after the receipt of the wound. Within an hour he voided a quantity of bloody urine. He was in extreme pain, which was aggravated by his being moved a distance of three leagues the same night. Soon the pain spread from his wound over his bowels, and delirium set in; he was then bled several times, and blisters were applied to his abdomen. Then followed intense pain in his right shoulder, and the wound in his back nearly mortified from his lying so long, but in seven weeks he was well enough to be sent to England. The journey excited fever, and peritonitis again set in; and a tumor formed in the site of the posterior wound, which was punctured at the end of a fortnight, and six ounces of pus having an urinous smell were discharged. The discharge continued for some time, and another abscess formed lower down, which was punctured in about three weeks, and a large quantity of pus of the same kind escaped. The abscess healed, and burst again and again; pain, emaciation, and frequent micturition, with actual lessening of the quantity of urine voided, together with the symptoms of renal colic, followed, and then at the expiration of seven months from the infliction of the wound, he passed *per urethram* something having the shape of a short, thick shrimp, which, upon examination proved to be a piece of cloth, covered with black grit. After this, he rapidly convalesced.

Diagnosis.—The situation and nature of the wound, and the presence of hæmaturia, or the escape of urine by the external wound, or some form of dysuria, accompanied by lumbar pains, are the most certain signs. Hæmaturia has been noted in the larger proportion of cases, and is so fairly constant a symptom that it ought to cause suspicion in cases in which there is neither dysuria, nor escape of urine by the wound, nor any evidence of urinary extravasation. If the hæmaturia is associated with, or followed by, traumatic peritonitis, the evidence becomes stronger. It must be borne in mind, however, that the kidney may be wounded without hæmaturia occurring, whilst hæmaturia may follow a blow without the kidney being wounded.

Prognosis.—Though dangerous, wounds of the kidney are by no means necessarily mortal. Hennen says:—

The slightest reflection on the situation and structure of the kidney, and on its various sympathies, will at once show the desperate nature of wounds inflicted on it, even with all the caution of a curative intention. The instances that I have observed where

¹ Op. cit., pp. 422 *et seq.*

recovery has been established, are very few indeed. If the patient has survived the first hemorrhage, the fever and peritoneal inflammation, with incessant hiccough and vomiting, and sympathy of the diaphragm and stomach, have generally cut him off; and if he has for a time escaped, excruciating pains, profuse suppuration from fistulous sores, hectic, and emaciation, have terminated his existence. Where the cure has been effected, there is reason to think that the ureter has been but slightly bruised, and the body of the kidney itself left untouched.

At the present day, however, we know from the success that has attended recent surgical operations upon the kidney, that this estimate of the danger of renal wounds is altogether too unfavorable. Haller, Bourienne, Borthwick,¹ Fallopius, Valleriola, Schenckius, La Motte, and other old writers, have given instances of recovery from incised and punctured wounds.

Sir A. Cooper mentions the case of a boy, whom he saw, who was struck in the back with a penknife; almost immediately he wished to make water, and passed a large quantity of blood. Hæmaturia continued for several days, but subsided by his remaining quiet in bed.

Mr. Ackerly,² of Liverpool, relates the case of a man, aged thirty, who was wounded in two places by the open blades of a pair of tailor's shears, the one entering the abdomen about two inches above the anterior superior spinous process of the ilium on the left side—from which wound about four inches of omentum protruded—the other entering near the spine, on the same side, just beneath the last rib. There were copious discharges of urine from the latter wound for two days. The omentum was cut away, and the bleeding vessels secured by ligatures. Recovery ensued in fourteen days.

Mr. J. Johnston³ records a case of recovery, after wound of the kidney, in a man aged thirty-two. The wound was inflicted with a large table-knife, with a blade of $8\frac{1}{2}$ inches, the whole of which penetrated the tissues. The peritoneal cavity was opened. Painful, spasmodic retraction of the testicle was the prominent symptom, and led the man to suppose that he had been stabbed in the groin. There was much hemorrhage from the wound, and within an hour after its infliction a pint of blood was passed by the urethra. Symptoms of peritonitis followed, and a peri-renal abscess had to be opened; quantities of urine escaped through the abscess-opening. The patient made a good recovery in about six weeks, and it is to be inferred, though it is not so stated, that a permanent urinary fistula was escaped.

In the Medical and Surgical History of the War of the Rebellion,⁴ it is stated that out of a total of 78 cases of gunshot wound of the kidney recorded during the war, 26 ended in recovery; in 6 of the successful cases, the liver was also wounded. A case is given of quite miraculous recovery after considerable hemorrhage, six days of neglect of treatment, repeated journeys of many miles, a convalescence complicated by typhoid fever, and a renal abscess which discharged externally, followed by an urinary fistula which subsequently closed. This case teaches the important lesson, that a surgeon should never abandon as hopeless any case of injury, however unpromising it may at first sight appear. Twenty-one additional instances of recovery from gunshot wounds, and 14 of recovery after incised or punctured wounds of the kidney, are collected from various sources, and referred to by the editor, Dr. Otis. No instance of punctured or incised wound of the kidney was, however, known to have occurred in the War of the Rebellion. The great sources of danger from these wounds are (1) hemorrhage, if the great vessels of the organ are injured; (2) peritonitis, if the front surface of the organ, or any of the adjacent viscera, are penetrated. If

¹ Hennen (op. cit., p. 425) refers to the cases of these three observers.

² Observations on Wounds of the Abdomen. Lond. Med. Gaz., vol. xx. p. 549. 1837.

³ Brit. Med. Jour., April 4, 1857, p. 275.

⁴ Op. cit., Part Second, Surgical Volume.

the wound is inflicted upon the posterior surface, and neither peritoneum nor the great vessels of the hilus are wounded, recovery may be looked for. Indeed, it is not too much to say that whilst the kidney may recover from very considerable lesions, mere punctures or incisions of its substance are attended with a very small amount of risk. Death from other causes has rendered it possible to prove the complete cicatrization of wounds of the kidney. In one instance, recorded by Legouest,¹ a kidney, which had been penetrated from before backwards near its centre, had upon each face a depressed, solid, fibrous cicatrix, with fibrous rays branching from it. Urinary fistula of long duration is not a common result, even after gunshot wounds, for it is only reported in one out of the twenty-six recoveries during the War of the Rebellion. The duration of life in the fatal cases has varied from a day or two, to eight or nine months, or more—the early deaths having been due to shock or hemorrhage, the later ones to protracted suppuration. In many cases the fatal result has been due to peritonitis, nephritis, and cystitis.

Treatment.—"The remedies consist of venesection, mild purgatives, such as manna, oil, etc., frequent emollient enemata, the warm bath generally, and local fomentations, so as to excite diaphoresis and to moderate urinary secretion; with a diet of the mildest kind, but much restricted in fluids, the indulgence in which, even in small quantities, should be avoided. Stimulants under any form, particularly those which can at all influence the urinary organs, and blisters and diuretics, are decidedly hurtful. The dressing should be extremely light, so as to admit of free percolation of the urine; the neighboring parts should be varnished over with some unctuous substance to prevent excoriation, and the bedding should be protected by oil-skin. By these means a few cases that have come to my knowledge have terminated favorably." So wrote Hennen, in 1818, and with the exception of venesection and frequent emollient enemata, these directions cannot be improved upon. The experience of recent times has not been favorable to venesection in abdominal wounds, and in the case of injuries to such organs as the spleen, liver, and kidney, the shock and hemorrhage resulting from the accident often render it unwarrantable. Mild purgatives and emollient enemata are indicated if the bowels, especially the large bowel, are loaded; but after these have been once freed of their contents, the quieter they are kept the better. It is, however, very undesirable that a mass of hardened feces should rest in the colon, and act as a source of irritation to the neighboring and injured kidney. The treatment of the wound cannot be too simple. It should be left open for drainage, unless it be a very large, incised wound, when one or more deep sutures may be introduced to bring a part of the edges together. Unless its course be very oblique, it will rarely be necessary to enlarge the wound for the purpose of preventing infiltration of urine, and in a case of gunshot wound, the tissues are at first protected by the eschar of the bullet track, and subsequently by a limiting wall of inflammatory lymph. If at a later period phlegmonous inflammation or extravasation occurs, free incisions are most important; and if a circumscribed collection of urine or blood is formed, repeated aspirations may bring about a cure. The importance of removing clots of blood from the bladder has been mentioned in describing the treatment of ruptured kidney, and it cannot be too fully emphasized. The catheter and warm-water injections should be first tried, but if these are insufficient, either owing to the quantity of coagula or to their continual formation, cystotomy should be performed without delay. It matters but little whether this be done by median or by lateral incision, as long as there is a free

¹ Chirurgie d'Armée, 2e éd., p. 403.

exit for the escape of the clots. It is impossible to read the account of Hennen's celebrated case, or to have witnessed the sufferings of Mr. Hilton's patient, to whom I have before referred, without feeling convinced that each of them would have been saved a world of pain had cystotomy been performed. In Hennen's case, moreover, the operation would doubtless have led to the early detection and removal of the foreign body in the bladder, to the expulsion of which, along the urethra, the agony of the latter period of the case was due.

Hemorrhage should be checked by the internal administration of large and quickly repeated doses of ergot, and by the local application of ice and well-applied pressure upon the loin; care must meanwhile be taken to secure good drainage of the wound. If life be threatened by hemorrhage or suppuration, the kidney ought to be removed by lumbar nephrectomy. Protrusion of the injured organ at the time of the accident, or subsequently from coughing, may also render its removal expedient.

Wounds of the Ureter.—With the exception of the gunshot wound of the ureter in the person of the Archbishop of Paris,¹ in 1848, and the doubtful case recorded by Hennen,² there does not appear to be any published instance of wound of the ureter alone. None occurred in the war of the Rebellion; and when the calibre of the ureter and its secure and protected position are considered, this is not surprising. In all the recorded cases of injured ureter, whether penetrating or subcutaneous wounds have been inflicted, and whether the kidney has been associated in the injury or not, it has always been the pelvic dilatation, that is the ureter close to the kidney, which has suffered. Hence the diagnosis, symptoms, sequelæ, and treatment of injured ureter, as far as our knowledge extends, in no way differ from those of rupture or wound of the kidney, nor is there any *a priori* reason for supposing that they should. The following are the notes of the case of the Archbishop referred to:—

During the revolution of 1848 (June 29), the Archbishop of Paris was wounded by a ball at the upper part of the lumbar region, on the right of and close to the spine. The ball was lodged in the body. He had intense suffering, great depression, paralysis of the limb, but no anæsthesia with it. After recovering from slight collapse, reaction set in, accompanied by continued and acute pain, more especially in the left leg and down the course of the sciatic nerve. Nausea and vomiting supervened; the countenance became pale and anxious; the abdomen was flaccid and not at all painful. The wound was enlarged, and unsuccessful attempts were made to extract the ball. There was no urine in the bladder, but a quantity escaped by the wound. Death ensued in eighteen hours. On examination, the ball was found to have fractured the transverse process of the third lumbar vertebra, to have then changed its direction and traversed the body of the same vertebra, and to have divided the cauda equina just below its origin. After leaving the vertebra the ball had changed its direction again, had passed up toward the left kidney, had divided the ureter near the pelvis, and, finally, had lodged in the psoas muscle. All the cellulo-fatty tissue about the left kidney was infiltrated with urine, and there was slight ecchymosis in the substance of the organ itself.

Mr. Holmes,³ a few years since, recorded a case of great interest, which, at the time, he considered to prove the possibility of a direct and uncomplicated wound of the ureter through the posterior parietes of the abdomen. A boy, aged 13 years, was stabbed by a clasp-knife, which entered the back just on the right of the middle line, and about on the level of the posterior superior spine of the ilium. The wound took a direction upwards and outwards, and through it there flowed for two weeks a quantity of a colorless,

¹ Gazette des hôpitaux, 1848.

² Op. cit., 3d ed., p. 430. Case LXXII.

³ Med.-Chir. Trans., vol. 1x.

odorless, neutral or slightly alkaline fluid, of sp. gr. 1008. After this time the flow ceased altogether. The author concluded that this fluid must be either urine from a punctured ureter, or cerebro-spinal fluid, and he strongly inclined to the view that it was not cerebro-spinal fluid. It is quite certain, however, from the composition of the fluid, that it was not ordinary urine, and was much more nearly like cerebro-spinal fluid; and as Mr. Holmes has, in a subsequent communication,¹ come to the conclusion that this case was really one of wound of the theca vertebralis, and not of the ureter, I need do no more than say that he has at least shown, by experiment on the dead subject, that it is possible to wound either the ureter or the theca vertebralis by a stab in the back, at the position of the wound in this boy.

There is another way in which the ureter not only may be, but has been, wounded, and that is during the removal of ovarian and other abdominal tumors, as well as in the removal of the uterus. In the complete removal of the uterus the ureter stands in very real danger of being divided, especially if the operation is being done for cancer of the cervix. It happened once to myself to divide the ureter on one side whilst removing the uterus for malignant disease; the cervix was so enlarged and infiltrated with cancer that it greatly exceeded the fundus in circumference, and it was quite impossible to excise the tissues clear of the disease without cutting out about half an inch of the right ureter, which was incorporated with the growth on the side of the cervix. The renal end of the divided ureter was turned into the vagina and retained there by a suture. Should the ureter be accidentally torn or cut across whilst removing an abdominal tumor, the renal end must be brought out through an opening made for this purpose in the loin, and fixed by a suture to the edge of the wound.

It was after an accident of this sort that Simon, of Heidelberg, for the first time successfully removed a kidney in order to rid his patient of a urinary fistula.

Wounds of the Supra-renal Capsule.—One case of gunshot wound of the left supra-renal capsule is described in the Medical and Surgical History of the American War of the Rebellion. The shot had traversed the left lung and the diaphragm, and had lodged in the supra-renal capsule, where it was found imbedded after death. The man lived four weeks, and died of pyæmia. He suffered “no hæmoptysis, not much oppression of breathing, scarcely any hemorrhage, no disorder of the uropoietic functions, and comparatively little shock at the outset—the reverse of what would be anticipated from Kölliker’s observation, that the supra-renal capsule is more highly supplied with nerves than any other glandular structure, and that the nervous branches are derived from the sympathetic, pneumogastric, and phrenic nerves.”

There are no clinical records of any case of uncomplicated wound of the supra-renal capsule; and we have no observations to show how far injury to these bodies would produce the symptoms of Addison’s disease, or lead to the retention in the blood of some poisonous substance which certain physiologists have imagined that it may be the function of these organs to remove.

PENETRATING WOUNDS INVOLVING THE LYMPHATICS AND BLOODVESSELS.—*Wounds of the thoracic duct* are very uncommon, and, with one or two exceptions, probably unknown. Quincke’s case was verified by a post-mortem examination; and Monro’s was also probably a genuine case of wounded

¹ Med.-Chir. Trans., vol. lxxv.

thoracic duct. The discharge of a milk-like fluid from a wound in the loin, especially if the wound were of the nature of a stab, or gunshot, would, as Benjamin Bell remarked, suggest this injury. But the secure position of the thoracic duct, not only in its short course below, but in its longer course above the diaphragm, makes an uncomplicated wound of this tube extremely improbable. Lying as it does between the aorta and vena cava, it is almost impossible to conceive of its being punctured or divided without one or both of its companion vessels being injured also; and in such a case death would occur before the symptoms due to the injury of the lymph-duct would have time to develop themselves.

Wounds of the smaller lymph-vessels must of a certainty occur whenever the mesentery, viscera, or parietes even, are wounded; but such wounds heal quickly, as do those of the small arteries and veins.

John Bell's perusal of his namesake, Benjamin's, very harmless suggestions as to the probable results of a wound of the "*receptaculum chyli*," inclined him to write some very uncharitable things,¹ which, with the knowledge of those who lived after him, he would have left unsaid, as he would have recognized that Benjamin Bell was sometimes wiser than himself.

Penetrating Wounds of the Bloodvessels of the Abdomen.—The bleeding which results from penetrating wounds proceeds from either (1) the vessels of the parietes; (2) the viscera, omentum, or mesenteries; or (3) the large blood-vessels, or their branches to the viscera or parietes. Wounds of the great vessels are, as a rule, fatal, the patients perishing before help can be procured. The bleeding from such vessels as the epigastric, intercostal, lumbar, or circumflex iliac arteries, is by no means trivial or unimportant, and may be fatal if trifled with or mismanaged.

The viscera, omenta, and mesenteries are so well supplied with vessels, that they can hardly be wounded without their vessels suffering. When any of the smaller vessels within the abdominal cavity are wounded, the pressure exerted by the abdominal parietes, and through them of the contained viscera, is often sufficient to control or check the hemorrhage. This pressure is, as remarked by Petit, a veritable compression which nature employs to suspend or moderate the effusion. The rapidity and amount of hemorrhage depend, therefore, upon the size of the vessel wounded, and the degree of resistance to effusion exerted by the contiguous structures. If the wounded vessel be large, the force with which the blood tends to escape will probably be greater than the resistance; if the force and the resistance nearly balance each other, it may happen that a slight extravasation will increase the resistance sufficiently to completely prevent further hemorrhage.

Symptoms.—When wounds of large vessels prove quickly fatal, the blood descends into the pelvis, the belly swells, and the patient grows pale and pulseless, anxious in aspect, restless, and cold, then becomes suffused with clammy cold sweats, and, after several convulsive movements, dies.

When the wounded vessel is under a certain size, the hemorrhage is slower, and some time elapses before the extravasation is considerable. After a time, a soft, dull fluctuating tumor may be felt in the lower part of the abdomen; the pressure made by the effused blood on the urinary bladder excites distressing efforts to micturate, and that on the large bowel leads to constipation and tenesmus. At a later period, the peritoneum becomes, perhaps, inflamed, the pulse grows feeble, and the alarming symptoms above described usher in death; or peritonitis may be escaped, and by slow degrees, if the hemorrhage ceases, the effused blood is absorbed and convalescence is established.

¹ Op. cit., 3d ed., p. 366, *et seq.*

Dr. Colles, in his lectures, relates the case of a carpenter who stumbled and fell upon the edge of a chisel, which he was carrying in his breeches-pocket; the chisel penetrated the peritoneal cavity, and in doing so, wounded the epigastric artery. The man, pale, exhausted, cold, and pulseless—in fact, collapsed and faint—died in the course of a few hours. The cavity of the peritoneum was found distended with blood.

Ravaton¹ relates the case of a soldier, wounded by a sword which entered the abdomen, and, passing between the viscera without injuring them, opened the vena cava. Blood at once filled the peritoneal cavity, and death was immediate. He mentions² another and similar case, in which both aorta and vena cava were opened without any other internal injury.

Hildanus records the case of a young man who was stabbed between the false ribs and the umbilicus, and who died instantly from internal hemorrhage from a wound of the unobliterated umbilical vein.

Sir E. Pakenham was killed on the spot at New Orleans, by hemorrhage from a wound in which the common iliac artery was divided; and Guthrie, on whose authority this statement is made, records a very similar accident³ to a soldier who was wounded by a musket-ball, which entered at the groin and made its exit at the back. When seen by a surgeon for the first time, on the fifth day after the accident, the foot and leg were mortified. The countenance had a cadaverous appearance; the pulse was small and weak; there were some nausea and retching, and the patient died eleven days after the injury. On post-mortem examination, the ball was found to have completely divided the external iliac artery; about a pint of coagulated blood, mixed with some excessively fetid pus, was collected in the pelvis; the ends of the artery had receded considerably from each other, and a coagulum had formed in each. There were signs of peritoneal inflammation, the intestines had not been wounded, and the ball in passing out had splintered the upper edge of the back of the ilium.

In South's *Chelius*⁴ is to be found the record of a case in which an iron spike traversed the abdomen of a man, aged fifty-two; tore the right common iliac vein; and deeply indented the third lumbar vertebra without injuring the viscera. The patient had vomiting, pain, and tenderness, and died on the third day. There were no marks of peritonitis, but the omentum was adherent to the external wound.

During the War of the Rebellion,⁵ an elongated ball entered one inch to the right of a soldier's umbilicus, passed inward through the intestine, and out close to the spine, dividing the lowest intercostal artery. The man died the same day from hemorrhage. On the same page of the History is the report of another fatal case, in which death occurred from repeated hemorrhages from the musculo-phrenic and superior epigastric arteries; the ball had entered two inches above and to the left of the ensiform cartilage, and passed out in the left hypochondrium, opposite to the spleen. The splenic flexure of the colon was gangrenous, and there was a large abscess-sac between the points of entrance and exit. An interesting case is also reported (p. 175), in which both epigastric arteries were completely divided by a ball which entered at one inguinal region and emerged at the other, cutting through the entire abdominal wall from one side to the other about half an inch above the pubis, and leaving a gaping wound about eight inches long. The man was convalescent on the twenty-sixth day. C. J. M. Langenbeck relates an instance of fatal hemorrhage from a stab in the belly, in which the bleeding was found to proceed from the ascending branch of the left colic artery.

Treatment.—It is important that there should be fixed rules in dealing with these cases of penetrating wound attended with hemorrhage from wounded vessels. The first is, that reliance must not be placed upon any astringents, or compression by pads and bandages. In hemorrhage from a wounded liver or kidney, the internal administration of ergot, and the local application of iced-compresses, are often of service, and are the only means available; but

¹ *Chirurgie d'Armée*, etc., Obs. CCXLIII.

² *Ibid.*, Obs. CCXLIV.

³ On Wounds and Injuries of the Abdomen, etc., p. 62, Case XCIII.

⁴ *System of Surgery*, vol. i. p. 458.

⁵ *Medical and Surgical History*, etc., Part II., Surg. Vol., p. 176.

when an artery or vein—whether of the parietes, of the omentum, or of one of the mesenteries—is the source of bleeding, there is the utmost danger in temporizing with such remedies. The second rule, therefore, should be to enlarge the wound when necessary, and to search for the source of hemorrhage. Ligatures or torsion should then be applied to the vessel at the wounded part, blood should be carefully removed from the peritoneum, and the external wound should be closed in the usual manner. Catgut ligatures are generally used for the adhesions and vessels divided in ovariectomy, and experience has shown that there is no danger in putting on a large number of them, and leaving them, cut short, in the cavity of the peritoneum. Care should be taken to cleanse the peritoneum from fluid blood and clots.

The pernicious doctrine of Jourdan, that surgery is powerless in lesions of the bloodvessels of the abdomen, ought not to paralyze the hand of the surgeon, who should in cases of free hemorrhage feel himself called on to expose and, if possible, secure the wounded vessel, whether in the walls of or within the abdomen, and should decline to rely on general measures, such as tents, compresses, and styptics. It is quite possible, however, that in some cases—such as that above referred to, in which the musculo-phrenic and superior epigastric arteries were injured—it might be impossible to ligate the vessel at the seat of the wound; but in that event the same rule should be followed as in injuries to vessels of the limbs—viz., the trunk should be tied between the wound and the heart. Thus, in the case of the musculo-phrenic, the internal mammary artery could be ligatured in the second or third intercostal space; for though the anastomosing currents are free and would soon be established, still a good chance would be afforded for the closure of the wound by clot. Even large trunks, when divided by shot, are sometimes completely closed as if by torsion, but in punctured or incised wounds this is seldom, if ever, the case.

ON WOUNDS OF THE ABDOMEN MADE BY THE SURGEON.—It would be out of the province of this article to describe in detail all the many wounds which the surgeon from time to time inflicts upon the abdomen in the useful exercise of his art, but it may be well to enumerate the chief of them, some of which will find place in subsequent portions of this article, and others in the articles on hernia, intestinal obstruction, and injuries and diseases of the pelvic organs.

1. *Opening the abdomen* for the relief of various sources of internal strangulation, including internal herniæ, bands, twists, obturator and ischiatic herniæ; for the excision of portions of the stomach or bowel when strictured, or the seat of malignant disease; or for the removal of other viscera, such as the kidney, spleen, uterine appendages, etc.

2. *Opening the stomach* for the removal of foreign bodies, and for the prevention of starvation in strictures of the œsophagus.

3. *Opening the small intestines* has been proposed for the removal of foreign bodies, and in cases of intussusception. It rarely, however, occurs that a foreign body becomes impacted in the bowel so as to require removal; and in intussusception, either the invaginated bowel can be pulled out, or the affected part, if sloughy, will require excision. The small intestine is sometimes opened for the relief of intestinal obstruction which is seated above the cæcum, and the cause of which cannot be made out. In these cases the opening should be made for the sake of giving relief to the patient, on the same grounds that the bladder is punctured in cases of impassable stricture.

I have opened the ileum a short distance above the cæcum, through a slightly-curved incision, one inch above the spine of the ilium and outer part of Poupart's ligament, on the right side; and immense relief from the anguish

of distension followed the evacuation of an enormous quantity of fluid fecal matter and gas.

4. *Opening the large intestine* is performed for the relief of intestinal obstruction. Either the cæcum, the ascending or descending colon, or the sigmoid flexure, may be the seat of the operation. In the ordinary operation of colotomy, whether on the right or left side, the peritoneum should be avoided. In this operation it is uncertain, in any given case, what spot on the ascending or descending colon will be reached through the incision. In left colotomy, any part from just below the splenic flexure to the sigmoid flexure, may present itself at the wound.

In some cases, such as those of imperforate or defective rectum, the sigmoid flexure should be opened in the left iliac fossa. This is the operation known by the name of Littre, having been first proposed by him in 1720, though it was first practised by M. Dubois in 1783. M. Huguier has recommended that the opening should be made in the right groin instead, because of the occasional deviation, in cases of deficiency of the rectum, of the sigmoid flexure to the right side, instead of its ending on the left. The cæcum has been opened in the right iliac region by an oblique incision above Poupart's ligament, by M. Pillore; and in a case related by Mr. Avery to the London Pathological Society, the cæcum was opened by an incision six inches long in the right groin.¹

5. *Opening the uterus* may be performed, first, by opening the peritoneal cavity, and secondly, by avoiding the peritoneum.

Opening the uterus through the peritoneum is generally done (1) by a longitudinal incision through the median line. I have twice had occasion to perform this operation, and once² with the result of saving both mother and child; in the other case,³ craniotomy had previously been employed, but without delivery *per vias naturales* having been made possible: the woman was in a most exhausted condition therefrom, and survived the operation only seventy-two hours.

(2) The lateral incision was anciently adopted, the left side being preferred, and the line of selection being along the outer edge of the rectus abdominis, for about six inches. This operation fell into disuse on account of the danger of wounding the epigastric artery, and the great tendency to retraction of the muscles. This is a point worth bearing in mind in the selection of the line of operation in nephrectomy.

(3) The transverse incision, recommended by Lauverjat, was made five inches long, between the edge of the rectus and the spinal column, and more or less high according to the elevation of the womb.

Opening the uterus without injuring the peritoneum has been performed in three different ways. (1) Dr. Physick proposed a transverse incision immediately above the pubis; the peritoneum was to be detached, as it easily can be, from the bladder and neck of the womb, and the womb was then to be opened without dividing the peritoneum. (2) M. Ritgen recommended that the neck of the uterus should be reached and opened by dividing the abdominal muscles along their attachment to the crest of the ilium, and then detaching the peritoneum. (3) M. Baudelocque commenced his incision near the spine of the pubis, and prolonged it, parallel to Poupart's ligament, beyond the anterior superior spine of the ilium on the side opposite to that on which the womb was most inclined. He did not divide the epigastric artery, but raised the peritoneum from the iliac fossa until he exposed the upper part of the vagina, which he opened, and then with his finger introduced into the os uteri drew the

¹ Trans. Path. Soc. Lond., vol. ii. p. 222, and vol. iv. p. 156.

² Trans. Obstet. Soc. Lond., 1883.

³ Lancet, 1879.

womb toward the wound in the parietes, making pressure meanwhile upon the fundus; when he had succeeded, he left the labor to be effected by uterine contractions. He preferred the left side for the operation.

6. *Opening the bladder above the pubis.*—This is done under exceptional circumstances for the removal of stone, but other less dangerous, and therefore preferable, methods of extraction have caused this to be rarely practised at the present day. It is called the high operation for stone, or hypogastric lithotomy, and is said to have been first performed in 1475, in Paris, by Colot, as an experiment on a criminal, by permission of Louis the Eleventh; the patient recovered in a fortnight. In Amussat's proceeding, as described by Malgaigne, the bladder is first distended with water; but in the method of Baudens, no injection into the bladder is previously made. Both operations are arranged so as not to wound the peritoneum, but this has not always been successfully carried out. Puncture of the bladder above the pubis, for the relief of urinary retention in enlarged prostate or impassable stricture, is still occasionally performed. The peritoneum is not wounded. The puncture may be made with an ordinary trocar and canula in the median line, about one or one and a half inches above the symphysis, either after, or without, making a previous incision through the skin and fat. Desault advises that the puncture should be made a little above the pubis, so as to avoid injuring the peritoneum. Or instead of an ordinary trocar and canula, the perforated needle of the aspirator may be used with advantage. I have on several occasions resorted to this latter measure for the temporary relief of retention.

7. *The operations for removing ovarian cysts and fibro-myomata of the uterus,* with Porro's, Freund's, Battey's, and Müller's operations, are all described in their appropriate chapters. There are no major operations in surgery which are more successful than ovariectomy, and none which exemplify more fully how much interference the peritoneal cavity tolerates, provided that every care be used to avoid sources of danger in the manipulations, and in the mode of cleansing and dressing the parts.

8. *The various operations on the kidney of nephrotomy, nephro-lithotomy, and nephrectomy* will be described in detail in a subsequent portion of this article: suffice it here to say that all may be, and that the two first always are, performed without opening the peritoneal cavity. Nephrectomy, if not performed by the lumbar incision, entails an incision of the peritoneum in two places.

9. *Cholecystotomy* appears to have met with a large measure of success; and with this operation may be mentioned those incisions and punctures for the treatment of hydatid and other cysts, and abscesses, of the various organs and structures of the abdomen.

10. *Operations for the ligature* of the iliac vessels, the abdominal aorta, the epigastric and other arteries, have been considered in a previous volume.¹

11. *The various operations for hernia*, its radical cure, and the relief of strangulation, will be dealt with in the article devoted to that subject.

12. *Paracentesis Abdominis.*—This is in fact a punctured wound of the abdomen, its object being the withdrawal of fluid from the peritoneal cavity or from an ovarian cyst. A small incision, about three-fourths of an inch long, should be made through the skin and fat over the linea alba, slightly above the mid-point between the umbilicus and pubes. A simple, round canula, with a trocar, the point of which should be very sharp and in the shape of a three-sided pyramid, should then be thrust through the linea alba into the abdomen, and when the instrument has well entered the cavity, the trocar should be withdrawn whilst the canula is pushed in further. The patient

¹ See Vol. II., 761 *et seq.*, *supra*.

should be lying near the edge of the bed, on his back, with the shoulders raised; or if there be pain or distress in moving, the operation may be performed whilst the patient lies upon his side. I have often tapped in this way without any inconvenience to myself, and without causing discomfort by movement to the patient. The canula should be about three inches long and one-quarter of an inch in diameter, and for convenience it should have an India-rubber tube fixed to its side, or readily adaptable to its end after the withdrawal of the trocar, to avoid wetting the bed, and for the purpose of conveying the fluid to a pail or basin on the floor by the side of the bed. The old plan of performing the operation whilst the patient was sitting in a chair, is not to be followed; though it is well still to employ what was absolutely needful to prevent syncope when this method was in vogue, namely, a broad flannel roller, or round-towel, applied around the belly, the ends being crossed behind and held by two assistants, who stand one on each side of the patient, and who by gently tightening the bandage maintain support on the organs and large vessels of the abdomen, whilst the fluid flows away. A hole should be cut in the centre of the bandage, so that the spot at which the puncture is to be made should be left uncovered. When all the fluid which can easily be drawn off has escaped, the canula should be withdrawn, and the wound covered with a small pad of lint secured by a broad strip of plaster; and a flannel roller should then be bound firmly around the abdomen.

Though this operation is commonly esteemed one of the simplest in surgery, there are, nevertheless, certain precautions requisite, for it is not without its dangers. The *first* precaution is to make sure that the bladder is empty; this should be done by the introduction of a catheter, or by getting the patient to pass water if the catheter is objected to, and not by trusting to percussion, as has been absurdly suggested. In some cases of ascites in which tapping is most needed, the whole of the front of the belly is dull on percussion, and in ovarian dropsy this is always the case. The *second* precaution, is not to re-introduce the trocar if the flow ceases before all the fluid has run off, lest it wound the intestine. Some blunt-ended probe, or a catheter, may be passed through the canula so as to keep aside the intestine or omentum, which by floating up against the end of the tube may effectually obstruct the flow. *Thirdly*, the surgeon should ascertain before making the puncture, and whilst the patient is in the position to be occupied during the operation, that the part is dull on percussion. This is especially needful in secondary tapplings, as it sometimes happens that a coil of intestine becomes adherent to the seat of previous puncture; we should, therefore, be on our guard in operating through the cicatrix of an old puncture, though the practice is sanctioned by many.¹ *Fourthly*, it is always well before surrounding the abdomen with the binder which is to be used during the operation, to make a mark with iodine, caustic, or ink, at the spot at which the puncture is to be made. With the abdominal walls distended, perhaps unequally, it is very easy to mistake the median line, more especially with the patient on his side, and only a small area of the surface exposed through the hole in the bandage. By not taking this precaution the epigastric artery has been wounded, and fatal hemorrhage has occurred from it. Dr. James Carmichael Smyth,² in 1790, enumerated ten cases in which death had been caused by wound of the epigastric artery or its branches, whilst performing paracentesis. South, in his notes

¹ A case illustrating the danger of wounding intestine which has become adherent to the parietes after a prior tapping, is recorded in the *Lancet* for 1827, vol. ix. p. 637. In the *Trans. Path. Soc. Lond.*, vol. ii. p. 203. is the record of a case in which the jejunum was wounded by a puncture made about an inch below the umbilicus; a fistula discharging bile existed for five weeks afterwards, and then closed.

² *Medical Communications*, vol. ii. p. 482.

to Chelius, has collected some such cases; two more (one fatal) in which the source of the bleeding is not stated, were witnessed by Sir Thomas Watson;¹ and Dr. F. H. Hamilton has recorded one in which the accident happened in his own hands, but in which the patient fortunately recovered.² Should such a catastrophe occur, and the consequent hemorrhage be at all free, as in all probability it would, the wound should be sufficiently enlarged to allow of the wounded vessel being secured, and no dependence should be placed on pressure or styptics. *Fifthly*, paracentesis should not be resorted to either in ascites or in ovarian dropsy, until it is absolutely indispensable. *Sixthly*, the surgeon should be careful to ascertain, by personal examination, that the supposed ascites is neither a pregnant uterus nor a distended bladder. This caution cannot be thought superfluous, for it is stated, on the authority of Sir Everard Home, that no less a surgeon than John Hunter once actually tapped a distended bladder in the belief that the disorder was ascites, and a well known surgeon told me that he himself had once been summoned to meet in consultation two physicians and the family attendant, for the purpose of performing paracentesis abdominis, and that the operation would have been done had my friend not discovered that the young lady's malady was pregnancy. In cases of encysted dropsy, or of dropsy associated with solid tumors or pregnancy, it will be requisite to tap elsewhere than in the median line—or in the median line at a much higher spot than that usually selected.

The linea semilunaris used to be the old seat of operation, but was abandoned on account of the risk of wounding the epigastric artery. In France, it was the custom to puncture at the mid-point of a line extending from the anterior superior spine of the ilium to the umbilicus.

I have in some few cases known oozing of fluid to follow paracentesis abdominis, and great advantage to accrue from the leakage. It certainly saves an early repetition of the operation. My learned colleague, Dr. Henry Thompson,³ attributes the cure of one of his cases of ascites in a great measure to the continued outflow of serum from the wound in the abdomen, and he has several times, when I have been called upon to do the operation in his ward, asked of me the question: "Is there any danger in prolonged percolation of fluid? Can it induce peritonitis by propagation of morbid action from the wound, and if not, how can it be artificially maintained?"

Acupuncture of the dropsical belly was occasionally performed years ago, where ordinary tapping was thought unsafe. It was many times performed by Dr. Robert Lee, and received the sanction of Sir Thomas Watson.⁴ As much as ten gallons of liquid have escaped from the little puncture made by the passage of a grooved needle. Two days and nights the fluid has continued to flow. In one instance, though only four ounces of liquid followed the puncture, that which was left behind gradually disappeared. The introduction by Dr. Southey of his capillary drainage-tubes has furnished us with the means of starting and maintaining with safety this small continuous outflow of ascitic fluid. The tubes have answered admirably in the cases in which I have employed them.

SUTURE OF THE INTESTINES.

At the present time, when the advances made in abdominal surgery are so rapid and so great, and more especially now that the surgical mind is bent

¹ Lectures on the Practice of Physic, 4th ed., vol. ii. p. 418.

² Princ. and Pract. of Surgery, p. 765. 1872.

³ Clinical Lectures and Commentaries, Case XI. p. 193.

⁴ Op. cit., 4th ed., vol. ii. p. 418.

upon the subject of enterorrhaphy, and particularly active as to the methods best adapted for the removal of portions of the intestines and stomach, a new Encyclopædia of Surgery would be imperfect if it did not contain a historical sketch of the use of sutures in closing wounds of the bowels. Whilst I was engaged in acquiring information on this subject for the present article, I turned, in the course of my researches, to the Fothergillian prize essay of Mr. Alfred Poland, one of my former teachers at Guy's Hospital. Here I found, besides other valuable information, so complete and methodical a summary of the several methods which have been adopted from time to time, that I make no apology for giving Mr. Poland's account in full—more especially as this admirable manuscript essay is not within the reach of foreign or provincial English readers.

If, in addition to this account, the reader will consult the interesting and very full historical survey of enterorrhaphy in Dr. Otis's Medical and Surgical History of the War of the Rebellion, he will learn nearly, if not quite, all that has been done in this field of surgery, a field which has been actively worked in since the thirteenth century. Mr. Poland writes:—

In enumerating the different kinds of suture, we shall advert to them in the order in which they have been recommended, according to the extent of the wound of the bowel. The following table will sufficiently indicate the plan adopted:—

1. Partial wounds.	1. Interrupted, noose, or loop suture.	<ul style="list-style-type: none"> a. Method of Palfyn. b. " " Ledran. c. " " Reybard. d. " " Jobert. e. Common interrupted suture.
	2. Uninterrupted, glover's, or continued suture.	<ul style="list-style-type: none"> a. The ordinary method of glover's suture. b. Method of Reybard. c. " " Bertrandi, or suture à points passés d. Spiral suture.
2. Complete, or nearly through the whole tube.	1. Upon a foreign body.	<ul style="list-style-type: none"> a. Method des quatre maîtres. b. " of Sabatier. c. " " Duverger. d. " " Jobert. e. Other varieties.
	2. With invagination.	<ul style="list-style-type: none"> a. Method of Ramdohr, and varieties. b. " " Reybard.
	3. With contact of serous surfaces.	<ul style="list-style-type: none"> a. Method of Jobert. b. " " Denans. c. " " Lambert. d. " " Gély. e. Other varieties and modifications.

Partial wounds, whether they are longitudinal or transverse, if exceedingly small, may be treated by the method adopted by Sir A. Cooper and others. The operator includes the aperture of the intestine in the forceps, and applies a silk ligature, to be carried beneath the point of the instrument, firmly tied upon the gut, and the ends cut off close to the intestine. This proceeding, however, will not apply to wounds larger than a simple puncture; hence, should a suture be determined upon, we must adopt one of two proceedings, viz., the interrupted or the uninterrupted suture.

I. THE INTERRUPTED, NOOSE, OR LOOP SUTURE.—a. *Method of Palfyn* (1710—1726). Palfyn passed a loop of thread through the middle of the wound of the intestine, fixing the threads to the integument by plaster, and thus approximated the bowel to the external wound. He brought the threads out through the wound, and did not stitch the gut to the integument, as stated by some authors.¹

b. *Method of Ledran* (1742).—Ledran took as many threads as he wished to make

¹ Lapeyronie's method slightly differed from Palfyn's, in that he inserted the thread through the mesenteric attachment, and stitched the bowel to the margin of the external wound. (Mém. de l'Acad. de Chir., t. i. p. 337. 1743.) Larrey successfully employed this method in a case of complete division of the ileum by a musket-ball. (Mém. de Chir. Mil. et Camp., t. ii. p. 160.)

points of suture, and threaded each in an ordinary sewing-needle. Having brought the edges of the wound together, he passed the needles directly through without any obliquity, about one-quarter of an inch apart. When all were put through, he removed the needles and tied together the threads of each side separately, forming two bundles, which were then twisted together into one. Thus the wounded portion of the bowel was puckered, and the points of suture approximated: it was considered that these puckers would prevent the edges of the wound from being separated, and would cause their mutual reunion without adhesion to any other part. The ends were fixed externally.

c. *Method of Reybard* (1827).—Reybard used a thin and polished, oval plate of deal, one and a half inches long by three-quarters of an inch wide. He suspended it by loops of thread, which traversed its middle, the threads being about two lines apart, and each end of the several threads being then inserted into a needle. This plate was passed into the bowel, and so placed that its greatest diameter corresponded to that of the wound, and was maintained there by passing the needles through the intestine about one-quarter of an inch from the edges. The two ends of each thread were then withdrawn and threaded together in a curved needle, which was carried through the integuments from within outward, about one-quarter of an inch from the external wound. The threads were then held by an assistant, and the bowel reduced, taking care to have sufficient traction to retain the wound of the intestine applied against the abdominal parietes. The threads were then laid over a roll of linen and placed parallel to the internal lip of the wound. About two days after, the threads were cut and the plate of wood passed by stool.

d. *Method of Jobert*.—The edges of the wound are turned in with a needle, and threads passed transversely through the borders, keeping the serous membranes in contact, and avoiding protrusion of the mucous coat in the intervals; then the threads are collected in one bundle and brought outside, as in Ledran's method, or as many points made of the interrupted suture as there are threads.

e. *Common interrupted suture*, without any modification, as many points of suture being made as are thought requisite. Dr. Gross made fourteen experiments, one only of which was fatal after complete division of the tube. In some, the stitches were four or five lines apart. In ten, the sutures were cut short, and in all they either passed or were in progress of passing into the cavity of the bowel. He remarks on the great rapidity with which single stitches are detached, when compared with the glover's suture. The latest period at which they were found adherent was the seventeenth day, and in two experiments they were detached on the seventh and eleventh days respectively. He quotes the following cases on record, where the suture was used, five successful and two fatal. The two fatal cases are quoted from Sir A. Cooper on Hernia. Three successful cases occurred in America; one is referred to in the *Edin. Med. and Surg. Journ.*, vol. xii. p. 27; and the fifth case is detailed in the *Med.-Chir. Review*, vol. xx. p. 182. However, there are several other remarkable instances—one in the *Med.-Chir. Review*, vol. vi. p. 557, a case of recovery under the care of Dr. Washburn; and another detailed by Dr. Fuchs, in the *Journ. der pract. Heilk.*, Februar, 1825, where he diagnosed intussusception, cut into the abdomen, drew out the invaginated bowel, cut into the gut, disengaged the invaginated portion, which was two feet in length, and united the wound by sutures, the patient recovering in fourteen days. Dieffenbach cut off three inches of a strangulated bowel, and reunited the gut by the interrupted suture; the patient remained well for several weeks, and died of other internal strangulation. The wound was found cicatrized.

II. THE UNINTERRUPTED SUTURE.—a. *Ordinary Glover's Suture*.—The two edges of the wound are brought together and held at either end; a needle armed with waxed thread is then passed obliquely through the edges, beginning from about a line from one of the angles. The thread is drawn through to within four or five inches of its extremity, and the needle again repassed in the same way, traversing the wound with the same obliquity, passing the thread over as in the whipping-stitch; this to be done as often as is requisite to complete the union of the wound, taking care to leave three or four inches of thread at the termination. The two ends of the suture are confided to an assistant, and the intestine returned into the abdomen, when these ends of the threads

are to be drawn tightly outwards, so as to appose the intestine to the internal surface of the external wound. The thread may be withdrawn five or six days after, and this is to be accomplished by cutting one end close to the parietes and gently pulling the other. Some prefer cutting both ends off after fixing them, and leaving the suture to find its way into the bowel if it can.

b. *Reybard's Modification*.—An ordinary sewing-needle is armed with a double thread, the free extremity of which bears, instead of a knot, a little roll of linen, one-fourth of an inch long. The thread is greased with oil or cerate. The suture is commenced by piercing from within outwards the edge of the wounded gut, near one of the angles, drawing the thread through, and leaving the roll of linen within the intestine; then the edges of the wound are to be brought together, and both sides pierced at once, and the suture continued as in the ordinary process, excepting that the points of suture are to be nearer together, and tightened a little more. In order to fasten the threads at the termination, the needle is to be passed back under the last stitch but one; then one of the threads is to be cut, and the last point of suture to be finished with a single thread; then the two threads are tied together, and the ends cut off close to the wound.

The ordinary method is the one generally adopted, and many experiments have been performed with this suture by Moebius, Shipton, Brewer, Thompson, Sir A. Cooper, Travers, Reybard, Pétrequin, and others.

Dr. Gross performed 17 experiments with this suture. In 2 the bowel was wounded transversely (in one completely divided); in 12 the wound was longitudinal, varying from half an inch to six inches; in 3 the wound was oblique. All the animals experimented on recovered, but 3 of them were killed too soon after the operation to allow of any positive conclusion as to the ultimate effects; in 8 the needle was carried through the whole thickness of the bowel, and in 5 the everted mucous membrane was pared off on a level with the surrounding surface; in 8 the suture was inserted through the fibrous lamella, or between the muscular and mucous coats; in 1 through all the layers of the tube, except the peritoneal.

Of these three methods, that of introducing the suture through the cellulo-fibrous lamella is the least objectionable, as it enables the serous surfaces to be brought into the most accurate apposition. The earliest date of passage of the thread into the bowel was on the thirty-fifth day; in other instances it was found partially adherent on the twenty-second, twenty-eighth, and thirty-first days. Gross, as well as Reybard and Pétrequin, dwells upon the importance of taking the stitches very close to each other, and of drawing them firmly in order to insure union. M. Moreau-Bontard has proposed to sew wounds of the intestine by excising the everted mucous membrane, and bringing the peritoneal coat and the exposed submucous tissue into contact, and he effects this object by passing the suture through the submucous cellular tissue. Dr. Gross gives six cases where the glover's suture was used, two only of which were fatal. Guy de Chauliac mentions a successful case in which he sewed intestines "*vulnerata secundum longum et latum cum sutura pelliperiorum*." Fallopius records a similar case. Garengéot¹ mentions a patient operated on by Guérin on whom this suture was used, but whose death took place on the third day.

Reybard read before the Académie de Médecine the case of a man, aged twenty-eight, who labored under a carcinomatous tumor of the sigmoid flexure of the colon; having diagnosed it, he cut into the abdomen, removed three inches of the intestine affected with the disease, tied the arteries of the mesocolon, and united the extremities of the divided bowel with the glover's suture; the suture was cut short, the intestine replaced in the abdomen, and the wound in the parietes sewed with three stitches. On the tenth day a copious evacuation was passed *per anum*, and on the thirty-eighth day the patient was pronounced well. After the lapse of six months, symptoms of cancerous disease of the intestine again set in, and the patient died twelve months after the operation. No autopsy could be obtained. Another remarkable case of recovery is quoted by Guthrie, viz., the case of Richard Cain, under the care of Mr. Jenkins, of Gosport.

c. *Method of Bertrandi*, or suture "*à points passés*," a variety of the continued suture. This has been recommended by Boyer, Sanson, Roux, Patissier, Lombard,

¹ *Traité des Opérations*, etc., 2e éd., tome i. p. 191. Paris, 1731.

Richerand, and others. The lips of the wound are held together, and pierced obliquely about two lines from the free edge; the thread is drawn through, and the needle is then repassed in the same way, on the same side which it has just quitted, about two lines further on, and this is continued on from one side to the other till completion, just as a tailor bastes two pieces of cloth. The intestine is then reduced, and the two ends of the thread fixed outside. These may be withdrawn some days after by cutting one end and pulling the other. Lombard successfully used Bertrandi's suture in 1778.

Modification of Béclard.—He arms the needle with two threads, one white and the other colored, so that when they require to be withdrawn the white thread has to be pulled at one end and the colored one at the other.

d. M. Hippolite Nuncianti, of Naples, has suggested a suture, called the *spiroidal*, which is nothing more than a variety of the continued. The serous surfaces of the lips of the wound are inverted and brought into contact. The suture is a single thread, which is carried along the wound alternately from left to right and from right to left in a spiral manner, and then by pulling the extremities of the thread, one at each angle of the wound, the lips of the wound are inverted and brought into contact. M. Nuncianti relates three successful cases.

It will be seen that the object of the continued suture is to produce absolute contact of the edges of the divided bowel in their entire extent, so as to prevent the danger of effusion. In doing this, however, we multiply and add to the danger of the wound and the risk of further ulceration. At least such is the argument raised by those who oppose the use of this suture. Many experiments and cases have been detailed to prove that it is not essential that absolute contact of every part of a wounded bowel should be secured in order to prevent effusion. Mr. S. Cooper gives the following strong recommendation: "Notwithstanding I have carefully read all the arguments adduced by Mr. Travers, in favor of stitching a divided bowel at as many points as possible, I still remain unconvinced of the advantage of such practice. If a case were to present itself to me in which a bowel partly cut through protruded, I should apply only a single suture made with a small sewing needle and a piece of fine silk. If the bowel were completely cut across, I should have no objection to attach its ends together by means of two or three stitches of the same kind. I coincide respecting the advantage of cutting off the ends of the ligature, instead of leaving them in the wound, as they act as extraneous substances."

Before entering on our next consideration respecting sutures, we must just advert to two proceedings, which have been generally proscribed.

(1) *Process of M. Littre.*—After gangrene, he proposes to tie the inferior end of the intestine in order to effect its obliteration, and then to attach the upper end into the ring so as to establish an artificial anus which the patient is to retain the rest of his life. Louis finds this process attended with difficulty, viz., to know how to distinguish the upper from the lower portion of the alimentary canal. The operation is generally deprecated as establishing a disgusting infirmity.

(2) *Process of Lapeyronie.*—He passes behind the division a double thread through a fold in the mesentery, and, after having pushed back the two ends of the intestine into the ring, makes use of the thread to prevent their entering the belly completely, by attaching it to the outside upon the dressing in any mode whatever. The result is an artificial anus, which may close up spontaneously, or by the aid of art.

Scarpa objects to this proceeding, because the ligature, 1, presents an impediment to the gradual retraction of the parts; 2, must soon cut through the mesentery, and may at the same time divide the vessels, causing fatal hemorrhage; 3, may cause ulceration and perforation. His objections have not been confirmed by others, and the process itself has succeeded. Reybard relates a case where the colon protruded, and was wounded in two-thirds of its circumference. The intestine was replaced, unsewed, and was retained near the parietal wound by a suture through the mesentery; the patient recovered with an artificial anus.

When the intestinal tube is *completely* or *nearly completely divided across*, there are three chief methods devised for dealing with it.

I. UNION OVER A FOREIGN BODY.—It has been proposed and tried to unite the divided ends upon a foreign body, and several varieties of this method exist.

a. *Method of the Quatres Maitres*¹ (middle of the thirteenth century).—It is said that they commenced by procuring the windpipe of an animal, introducing one extremity of this tube into the upper end of the divided gut, and inserting the other into the lower end; and that they then approximated the ends of the two bleeding circles in order to adjust them, and kept them in contact by means of several points of suture.

Jamerius, Roger, and Theodoric supported the canal by a canula of elder wood.

William of Salicet recommended a dry, hardened bowel of some animal. Louis tried the method on two dogs, and they recovered.² Vogel tells us that a veterinary surgeon, in 1704, opened the abdomen of an ox affected with obstinate constipation; he cut away the mortified portion of intestine, and sewed the ends of the bowel over a tube of wood; the cylinder was soon voided *per anum*, and the animal lived several years.³

Dr. Watson, in 1790, excised a portion, four or five inches, of the bowel of a large dog, and sewed the divided extremities over a cylinder of isinglass; the animal perfectly recovered.⁴

b. *Method of Sabatier*.—Sabatier, Ritch, Desault, and Chopart substituted a piece of playing-card besmeared with essence of turpentine or oil of St. John's wort, or varnished in any manner whatever.

c. *Method of Duverger* (1745).—He used a portion of prepared calf's trachea, furnished with three loops of thread, placed at equal distances, each end being armed with a small curved needle. It was first put into hot wine, to make it more supple and warm, and afterwards steeped in a mixture of Commander's balsam and balsam of Peru. He then introduced it into the intestine in such a way that it supported the two ends, and by means of the curved needles he made three points of interrupted suture, passing them from within to without, three or four lines from the wounded edges; the knots were made at one side of the wound.

Duverger's case is probably the only authentic example of this plan succeeding in the human subject. He cut off a portion of mortified intestine, in a case of strangulated hernia, introduced a portion of the trachea of a calf, brought the divided intestine over it, and fastened it by a suture. The trachea was passed on the twenty-first day, and the external wound closed on the fortieth. The patient recovered. Sir A. Cooper repeated the experiment of Duverger; on the sixteenth day the animal was killed, and the union was complete.

d. *Method of Jobert* (1824).—When omentum presents itself in front of the bowel, he seizes a fold of it, interposes the fold between the edges of the wound, and then brings the lips of the wound together, uniting the whole by the suture of Ledran. At the autopsy there is found in the intestine a floating layer of omentum.

All these modes of trying to establish the continuity of the bowel by the introduction of a foreign body or tube, and uniting the intestine over it, are attended with so much difficulty and danger, and give such bad results, that their advocates have quite discarded them for the present.

II. UNION OF DIVIDED INTESTINE BY INVAGINATION.—a. *Method of Ramdohr* (1730).—Ramdohr, having under treatment a soldier, in whom the continuity of the intestinal tube had been destroyed, cut off a large part of the intestine, and joined the two sound ends together, by inserting the upper end within the lower one, and fixing them in this position by a point of suture moderately tightened, the ligature being also employed to keep them at the same time near the external wound. The patient recovered, and the feces continued to pass entirely by the rectum in the natural way. About a year after the operation he died of another affection. The parts were removed and sent to Moebius, who showed them to Heister. They exhibited, according to the latter author, union of the two ends of the bowel together, and their consolidation with a part of the abdomen. Heister made experiments on dogs in this manner, but without success. Moebius attempted to repeat Ramdohr's operation upon a dog, but he

¹ Four famous monks, who practised surgery together at Paris. The method was to unite the wound of the intestine by direct apposition of the divided edges, supporting the intestine by a firm cylinder introduced within it.

² Mém. de l'Acad. de Chirurgie.

³ Sandifort, Thesaurus Dissertationum, etc., tom. ii.

⁴ Medical Communications, vol. ii.

could not succeed in insinuating the upper part of the divided bowel into the lower one, on account of the contraction of the two ends of the intestinal tube and the smallness of the canal.

Dr. T. Smith, of Philadelphia, also tried this method, but could not succeed. He divided the intestine of a dog transversely, and having inserted a piece of candle into that portion which was supposed to be the uppermost, he endeavored to introduce the superior within the inferior, but the ends became so inverted that it was found utterly impossible to succeed. Hennen applied the glover's suture to the two ends thus invaginated. Vermale enveloped the ends of the intestine in a fold of the mesentery, which he comprised in the suture. Ritch placed in the bowel a varnished card rolled up; then invaginated and passed a loop of thread through the two ends of the intestine, and the cylinder of card at the same time, tied the threads two or three inches from the intestine, and secured them in the external wound.

Jobert traversed the anterior part of the upper end with a silk thread armed with two needles, and then passed these into the lower end from within outwards, when by gentle traction, he introduced one end of the bowel inside the other. This method appears to have succeeded in a very small number of cases. Boyer performed it in one case, where he had to divide the mesentery and tie seven or eight vessels, but the patient died from extravasation; in another case he could not complete the operation. Velpeau saw another case in which this procedure was attempted at the Hôpital St. Louis, but in which the patient died on the following day. MM. Lavielle, Chemery-Halé, Schmid, and some others, also relate instances of cure.

An interesting, successful case is recorded by Dr. Pilcher,¹ where the ileum was divided diagonally across, with two inches of the mesentery. Invagination was effected, the lower end being inserted in the upper, and maintained by three points of suture. The patient was well on the nineteenth day.

There are three great difficulties to be overcome in this operation:—

(1) To distinguish the upper end of the intestine from the lower. The only means proposed by Louis is to retain both ends outside, and administer a purgative; if the wound be in the large intestine, an enema is best.

(2) To insert the upper end into the lower. The difficulty to be overcome is the contraction of the lower end of the bowel, which may be avoided by seizing the principal diameters at their four extremities, with four forceps; then the upper end is to be grasped four or five inches above its division, and properly compressed and then invaginated.

(3) A mucous membrane is apposed to a serous one, and cannot unite with it. However, the union may take place by false membranes, and by means of adhesions with the surrounding parts.

b. *Method of Reybard.*—The surgeon first incises the mesentery to the extent of a few lines; he afterwards passes, a little above the wound, a thread, one end of which remains within the canal, while the other hangs outside. According to Reybard, two nooses thus adjusted will be found sufficient, that is, one on each extremity of the antero-posterior diameter of the gut. By the aid also of a needle we are enabled to pass the inner extremity of each thread from within outwards, and through the lower end of the intestine, in order to invaginate the two portions methodically, and to terminate by fastening each point of suture with a knot. Although Reybard has successfully performed the operation, he yet unreservedly condemns it, and points out its disadvantages and dangers in his *Memoir on Artificial Anus*.

III. UNION BY CONTACT OF THE SEROUS SURFACES.—a. *Method of Jobert (1824).* Jobert conceived the idea of putting the serous membranes in contact by means of a new kind of invagination. The upper end being well recognized, the patient is laid on his back, with the muscles of his abdomen as relaxed as possible, and the mesentery of each end is dissected off to the extent of nearly one-third of an inch. There is always some flow of blood, which need not be stopped, as it is an obstacle to inflammatory action. But if the hemorrhage is too abundant, temporary ligatures are applied, and removed after the operation. This first step finished, the surgeon seizes the upper end with his left hand; with his right he takes a thread five or six inches long, furnished with two ordinary needles, and traverses with one needle the anterior wall of the intestine from within outwards, two inches from the wound, in such a way as to leave in the

¹ American Journal of the Medical Sciences, vol. xlii.

puncture a loop, the two ends of which are confided to an assistant; a second thread is passed in the same manner across the posterior wall. Then abandoning the upper end, the surgeon proceeds with his finger, or still better, with the dissecting forceps, to double the lower end inside itself, so that the serous membrane is on the inside. Having done this, the left index finger is introduced to sustain it and serve as a conductor for the needles. The two needles of the anterior loop are taken and passed in turn along the radial border of this finger from within outwards, through the double part of the inferior end, and brought out at a distance of one line from each other. The needles of the posterior loop are conducted in the same way on the ulnar side of the finger, traversing the intestine at that spot. The two ends of the intestine are then gently brought together, and when almost mouth to mouth, the finger is withdrawn; and on gently pulling the ends of the threads, with the aid of a round, polished body, the upper end is by degrees introduced into the lower. The intestine is then reduced into the abdomen, and the threads twisted together, brought out at the lower angle of the external wound, and fastened to the parietes by plaster. On the fourth or fifth day the cicatrix is formed, and the threads may be withdrawn. Jobert relates two cases of this operation;¹ both patients died within a few hours. Dr. Gross, and MM. Bégin, Reybard, and Pétrequin have made experiments with this method. It is generally deprecated on account of its difficulty, the violence done to the parts, the uncertainty of its results, and the impossibility of distinguishing the lower extremity of the intestine with certainty.

b. *Method of Denans* (1826).—The surgeon employs three small hollow metallic cylinders. He places one in each end of the intestine; after which a portion of each end is doubled into its respective cylinder. The third cylinder, which is somewhat smaller, is then introduced inside the two others, in such a manner as to act as a rod, axis, or support to both. A noose of thread embraces them, and secures all the three on two different points of the intestinal circle. The ends of the suture are divided near the peritoneum, and the whole is returned and left in the belly. The agglutination of the parts soon takes place; everything which is pressed between the three cylinders becomes gangrenous and detached, and the rings, becoming free, are carried off by stool. Denans simplified this process still more by doing away with the sutures, which he found unnecessary. Who would venture to leave the intestine in this manner in the belly? Who would guarantee that the metallic tubes would not perforate the intestine?

c. *Method of Lembert* (1826).—The surgeon passes with a needle as many nooses of thread as he wishes to make points of suture, first through the thickness of the walls of the upper end of the bowel and afterwards through those of the lower end. He introduces the point of this needle upon the external surface of the gut at the distance of two or three lines from the wound, causes it to make its way through the tissues as far down as the mucous membrane, brings it out at two lines distant from its place of entrance, and succeeds in this manner in adjusting his noose of thread. He then applies his needle with the same precaution upon the external surface and into the tissues of the rectal end of the bowel. He introduces successively and in the same manner the number of threads which he deems advisable, and afterwards knots them in order to complete the suture. By making traction upon nooses of this kind, the lips of the wound are compelled to become reversed upon their internal surfaces.

Dr. Gross performed 23 experiments with this method, but has deduced no conclusion, nor given any analysis of the results. In 9 animals the bowel was completely divided, and 4 died; two with fecal effusion. The results of the experiments on partial wounds of the bowel with this suture were very favorable; one dog only perished. They also tended to show the rapidity with which single points of suture passed into the bowel.

Cases in which this suture has been used:—

1. Jobert: Recovery. See Velpeau, Méd. Opérat., tome iv. p. 143.
2. Dieffenbach: Death from other causes. Brit. and For. Med.-Chir. Rev., vol. iii. p. 517.
3. Jobert: Recovery. Archives Gén. de Méd., Mars, 1837.
4. Baudens: Recovery. Clinique Chirurgicale.
5. Baudens: Death. “ “
6. Liégard: Result not stated. Velpeau, Méd. Op., tome iv. p. 143.
7. Jobert: Death. Archives Gén. de Méd.
8. “ “ “ “ “

¹ Archives Gén. de Médecine, 1824.

M. Roux, in endeavoring to remedy an intestino-vaginal fistula, opened the abdomen, divided the intestine in two places immediately above and below its point of adhesion to the vagina, as he thought, and united the extremities by three points of suture according to Lembert's method. The operation lasted one and one-quarter hours, and the patient died in thirty-eight hours. On dissection, it was found that the ileum had been divided two and a half inches above the artificial anus, but that, instead of dividing the small intestine below that point, the operator had severed the sigmoid flexure of the colon and sewed the small intestine to the end of it.¹

d. *Method of Gély* (1844).—This is a modification of Lembert's method, to which M. Gély raises the following objections, viz., (a) that it does not securely close the wound unless the points of suture are tolerably near together; and (b) that the danger of inflammation is necessarily increased with the number of stitches.

Gély remarks that a suture ought to possess the following points of recommendation : (1) to so thoroughly close the wound as to obviate all danger of either immediate or secondary effusion ; (2) to present such an arrangement that neither the knot nor any portion of it is visible on the peritoneal surface ; (3) to certainly pass into the intestine ; (4) to be easily executed and applicable in every case.

The suture recommended may be practised with one or two needles, two preferably ; they should be fine, but a little larger than the thread. One of them is inserted parallel with the wound, outside and a line or so behind one of the extremities of the wound, is carried for two or three lines into the cavity of the intestine, and is then brought out on the peritoneal surface again ; precisely the same is done with the opposite needle ; the threads are then crossed, the left needle is now introduced into the puncture, through which the right needle has just passed, and a stitch similar to the first made is taken with it ; and a like stitch is made in a like manner with the right needle. As many stitches are thus made, parallel to each side of the wound, as its extent may require ; and it then only remains to tie the threads and tighten the stitches sufficiently ; this is accomplished by pulling the threads with dissecting forceps at each point where they cross the wound, at the same time inverting the lips of the wound, which soon become so perfectly coaptated that the thread is completely concealed between them ; finally, the extremities of the thread are knotted and cut close, and the knot is as effectually concealed as the rest of the suture.

When the needles are crossed, it is not indispensable to pass them exactly into the orifice which the opposite one has traversed ; and it both facilitates and hastens the operation to tighten and knot the threads each time that they are crossed. An essential point is to make the corresponding stitches at the opposite sides of the wound of equal length, as otherwise the wound would be puckered. M. Gély's experiments on animals are scarcely sufficiently numerous, but as far as they go they are favorable to this method. He has twice successfully applied it in the human subject. A sailor received a wound in the left lumbar region, through which twenty-seven and a half inches of bowel with a portion of omentum protruded. After exposure and constriction by the abdominal parietes for two hours, two small wounds in the protruded gut were secured by the above suture, and the intestine returned. The patient recovered without any serious symptom in twenty days.² In the second case, a small wound was inflicted on the intestine during the operation for strangulated hernia. Gély secured the wound with a stitch of his suture, and returned the intestine. The patient recovered.³

e. *Method of Amussat* (1834).—This surgeon has experimented on animals by placing in the intestine a narrow piece of cork, expanded at its ends and narrowed at its centre, so as to present a central groove or furrow. The two ends of the intestine are then invaginated, so that both cover the cork, and are tied on it tightly with a strong thread ; and all that portion of intestine passing beyond the ligature is cut off with scissors.

Malgaigne remarks that there is something astonishing in this proceeding, and that before trying it on the human subject it requires further meditation and experiment.

¹ Recueil de Mém. de Méd., etc., tome xii.

² Annales de Chir. Nos. 48, 49.

³ Prof. Emmert, of Berne (1862), has proposed a plan which combines the stitch of Lembert with the loop of Ledran and the darning point of Bertrandi. He considers that it obviates the chief objection to Lembert's and Gély's methods. Dr. Vézien, of Paris (1871), employs the interrupted suture, knotted within, instead of on the outside of the bowel.

f. The other varieties are merely speculative proposals which we do not feel justified in recording.

Such, then, are the endless varieties of methods proposed for applying sutures to wounded intestines. Their merits may be summed up in a very few words. In partial wounds, the ordinary interrupted suture is the best. In complete division, or nearly so, three proceedings have each met with great success: (1) the ordinary interrupted suture; (2) the ordinary uninterrupted suture; and (3) attachment of the gut to the external wound. The first two are to be preferred; but experience and facts have not as yet decided their value relative to one another. With the third, we run the risk of establishing an artificial anus.

RETRO-PERITONEAL EXTRAVASATION AND SUPPURATION.

EXTRAVASATION INTO THE SUB-PERITONEAL OR RETRO-PERITONEAL TISSUES may be either of air, blood, urine, feces, or pus.

Air.—The source of the air is not always traceable, but its distribution is often very extensive. In a case already alluded to,¹ of rupture of the ileum just at the entrance of a hernial sac, there was a large quantity of air behind the peritoneum of the pelvis and both loins, and it had diffused itself along the vertebræ behind the diaphragm, into the posterior mediastinum and thence to the neck, from which it spread downwards, guided by the cervical fascia, to the shoulders, arms, and pectoral regions. All these parts were distinctly distended with air, and crepitant to the touch. The source of the air could not however be traced: there was no injury to the lungs, and the possible and only apparent source was a perineal incision which had been performed on account of a rupture of the urethra complicated with fracture of the pelvis.

In an interesting case under the care of Dr. Cayley, in the Middlesex Hospital, of aneurisms of the cœliac axis and superior mesenteric artery, for the treatment of which compression by means of the abdominal tourniquet had been employed, there was extensive emphysema in the cellular tissue behind the ascending colon. The small intestines were ecchymosed, and at one spot the coats were thinned, and there was some submucous emphysema. The large intestines were normal. It is quite possible that the air in this case had simply transuded into the retro-peritoneal tissues through the thinned walls of the ileum. Wounds of the loins, groins, and perineum, whether complicated with wounds of the bowel or not, and fractures of the lower ribs with lung-injury, may be the cause of this form of extravasation. Decomposition may in some cases explain the presence of gas. Retro-peritoneal abscess opening into bowel may of course give rise to it.

Blood may be effused as the result of injury from an artery (as in a case already mentioned of ruptured mesentery and inner coat of the aorta), from a vein, or from capillaries. Violence inflicted upon the loins or pelvis is very likely to cause extensive extravasation of blood into and beyond these regions, and the hæmatoma so formed may, after a varying period of from several days to some few months, break down and suppurate. One might refer to many cases in which most extensive retro-peritoneal hemorrhage has ensued from fracture of the pelvis or lumbar spine. Injuries to the loin are sometimes followed by extravasation beneath the capsule of the kidney, as well as into the abundant peri-renal cellular and fatty tissue, without, it may be, any rupture of the capsule or distinct laceration of the renal substance. Some of the most frequent hemorrhages into the pelvis are those which are known as “sub-peritoneal, or encysted, pelvic hæmatocèles:” in these cases a vaginal or rectal examination will reveal a soft, smooth, and elastic or fluctuating

¹ See contusion and rupture of hernia.

mass in the pelvis, fixing or displacing the uterus, the os and cervix of which may be flattened against the symphysis pubis, or against the front of the abdominal wall immediately above the symphysis. As the extravasation increases, there are fulness, dulness, tenderness, and a sense of resistance in one or both iliac fossæ, or in the hypogastric region, and extending sometimes even as high as the umbilicus. There is too in these cases a sense of bearing down about the pelvis, with frequent desire to evacuate the bowels and bladder, though nothing but mucus passes from the rectum, and retention frustrates the frequent desire to micturate. Occasionally the posterior vaginal wall is pressed down as low as the perineum, or may even be prolapsed, by the enormous extravasation beneath the peritoneum in Douglas's pouch.

After some days the effused blood becomes more solid, and the tumor more irregular, and it is by degrees absorbed; or after becoming harder, partly from coagulation and partly from inflammatory effusion around it, it may disintegrate and be even softer than when first poured out. Under these circumstances, the symptoms of retro-peritoneal suppuration will arise.

The sources of blood vary in the different regions; but everywhere the retro-peritoneal tissues are rich in bloodvessels, and the anastomoses between the vessels of the parietes and those of the viscera are numerous and important, both in the loins and pelvis. The rupture of muscular tissue, such as that of the *psoas*, *iliacus*, and *quadratus lumborum*, is occasionally the cause of very free hemorrhage. Sometimes the blood is derived from one of the venous plexuses, namely, the uterine, ovarian, hemorrhoidal, vesical, or prostatic, or from the trunks or branches of the arteries to those organs.

The rupture of an aneurism of the abdominal aorta is an occasional source of most extensive retro-peritoneal hemorrhage. The extent of the effusion in such cases is sometimes astounding, for the blood by degrees dissects up the peritoneum, and permeates the cellular tissue in every direction, causing the ribs and loins to bulge outwards; it may also carry forwards the posterior and lateral layer of peritoneum, and the abdominal viscera, so that the abdomen protrudes in front; and it descends along the *psoas* and *iliacus* until a fluctuating tumor is formed in each groin, even below the level of Poupart's ligament. There is usually not the least pulsation in such swellings, and unless the history of the case is known, the diagnosis is very difficult if not actually impossible. In some cases there may have been an attack of syncope to mark the bursting of the aneurism, but life may continue long after this, and the slow course of the disease, with the absence of every characteristic sign of aneurism, will probably lead to the supposition that the affection is malignant.

Erosion of the vertebræ from the pressure of the aneurism may give rise to more or less pain, or even to some degree of curvature, and then there is a risk that the swelling in the iliac region, or in the course of the *psoas* muscle, may lead to the diagnosis of lumbar caries with abscess. To open such a swelling on the supposition that it was an abscess, would of course be a serious, and might even prove a fatal, mistake.

Sometimes there is nothing to indicate the exact time at which the aneurismal sac has given way, though from the lamination of the clot found in the tissues after death, it is certain that the blood must have been effused gradually, and for many weeks, perhaps some months, before death. The extravasation has been greatest in the cases in which the aneurism has been seated at some spot above the superior mesenteric artery.

The mode of death may be from acute or chronic peritonitis, or from syncope, but more generally from anæmia—the blood extravasated being as really lost to the individual as if it had escaped through an open wound. Still, as the effusion is gradual, the downward course of the patient is gradual

also; but day by day, week by week, the life and strength are slowly worn away. A few cases of ruptured abdominal aneurism leading to retro-peritoneal hemorrhage are recorded in the London Pathological Society's Transactions.¹

In one of them²—a case which I had seen during life and examined after death—the enormous tumor had everywhere pulsated, nothing but skin and condensed cellular tissue formed its posterior limit, and in front it had ruptured into the peritoneum just above the cæcum. Dr. Habershon has mentioned to me a very interesting case in a gentleman under his care, whose death was very slowly brought about by the rupture of an abdominal aortic aneurism, and the gradual effusion of blood behind the peritoneum. A very similar clinical course and pathological condition occur in ruptured aneurisms of the thoracic aorta, as is shown by a case of my colleague Dr. Coupland.³ and others.

Another cause of retro-peritoneal hemorrhage is ulceration by pressure of an abscess or a tumor. A case will be hereafter mentioned in which stricture of the œsophagus set up suppuration behind the diaphragm, and death resulted from hemorrhage from the aorta, the coats of which were ulcerated through just above the celiac axis.

Urine may be extravasated into the retro-peritoneal tissue of the loin from rupture of the kidney or its pelvis, or from ulceration or direct wound of those parts, the result of operation or accident. Ulceration of the ureter from the pressure of a morbid growth has been known to give rise to urinary extravasation in the iliac region, as in the case of a man aged 67, who was admitted under Mr. Clark's care into the Middlesex Hospital, for a large sarcomatous tumor the size of a cocoanut, between the rectum and bladder, beneath the peritoneum. The tumor invaded the bladder, and caused complete ulceration of the right ureter about two and a half inches above its lower end. The ends of the ureter were ragged and sloughy, and there was a quantity of brownish fluid and sloughing cellular tissue beneath the peritoneum in the right iliac region. Into the sub-peritoneal tissue of the pelvis, urine escapes from the bladder after rupture; or through an ulcerous or fistulous opening caused by syphilis or other necrotic process, arising either from within or outside the bladder walls. When urine escapes from the kidney into the loin, it diffuses itself widely, and may displace the over-lying viscera—liver, spleen, etc.—pushing them considerably forwards.

The inflammation excited may run on to suppuration, with pointing in the loin or groin, or the cellulitis may stop short of suppuration, and become chronic in character, spreading slowly towards the iliac fossa and brim of the pelvis, and causing contraction of the ilio-psoas muscle. Under these circumstances, a firm, hard swelling will remain in the iliac or lumbar region for many months, but may ultimately clear up, and the muscular contraction will yield to shampooing or one of the many modes of making extension. In some instances the effused urine becomes encapsuled within a thick-walled cyst of inflammatory formation, and with the cavity of this cyst, which may contain pus as well as urine, the kidney communicates at its point of rupture or ulceration. The urine contained in this false cavity is sometimes very dilute, and it has been supposed that this is the reason why the destructive changes which so generally follow urinary extravasations are sometimes escaped. It is not a fact, however, that the urine which escapes from a ruptured kidney is as a rule deficient in urea, and therefore less irritating than normal urine.

¹ See especially vols. xix., xxi., xxii., and xxxiv., in the last of which a striking case is recorded by Dr. Silcock.

² Trans. Path. Soc. Lond., vol. xxii. p. 104.

³ Ibid., vol. xxiv. p. 54.

On the contrary, there are cases in which it has been shown that urea has been in excess. Mr. Bennett May¹ has put on record an interesting case in which the effused urine was exactly like that passed by the urethra; and Prof. Marshall² has quite recently published one in which the fluid withdrawn from the loin contained 5.5 per cent. of urea, which is greatly in excess of that in healthy urine. There is, however, good ground for believing that urine, when not putrid or purulent, and if not extravasated in very large quantity, does not necessarily excite suppuration or sloughing of the tissues outside the peritoneum; nor when in its cavity does inflammation of the peritoneum always arise. Recorded cases of injured kidney show that the urine sometimes escapes very slowly into the tissues around; and days or weeks, or even months, may elapse before there is any local swelling sufficient to suggest extravasation, and without hæmaturia or other urinary symptom to indicate renal lesion.

After rupture of the bladder, urine diffuses itself more or less widely in the pelvis, or passes upwards into the iliac fossa, or spreads along the front wall of the abdomen—from which the peritoneum may have been largely detached by the injury—nearly as high as the umbilicus, or may penetrate along the course of the obturator vessels into the thigh. Acute peritonitis, too, generally occurs, and leads to death in a few days; but pus may form and be discharged into the peritoneal cavity, the bladder, or the rectum, or through fistulous openings in the abdominal wall. I have had two cases of recovery after rupture of the bladder, in one of which the abscess burst into the bladder,³ and in the other into the rectum.⁴

Fæces escape into the retro-peritoneal tissues from the ascending and descending colon, the cæcum, the sigmoid flexure, the rectum, and the second and third parts of the duodenum, as the consequence either of injury, or of ulceration from disease. Fæces may also escape from any other portion of the bowel, if adhesions have fixed it to the parietal peritoneum, through which the intestinal contents will then pass, should perforation occur.

Cancerous, tuberculous, dysenteric, and other forms of ulcer; simple inflammation followed by ulceration; obstruction followed by ulceration or sloughing; and abscess opening into the bowel, are the common causes of fecal extravasation. As in the ischio-rectal fossa, so in the loin, groin, pelvis, or back, an abscess may form in the loose cellular tissue and open into the intestine, and subsequently fecal matter may be extravasated into the abscess. Sub-parietal ruptures and penetrating wounds are also occasional causes.

In long-standing cases a fecal abscess may open externally, as well as into the intestine. The following case, which was under the care of Dr. Coupland, in the Middlesex Hospital, is a good example:—

R. J., aged forty-five, had in the left lumbar region a fistulous opening, $1\frac{1}{2}$ inches in length, and communicating directly with a fecal abscess. The liver was adherent to the diaphragm by numerous firm, fibrous bands, and the left edge of the left lobe was firmly adherent to the stomach, spleen, and abdominal wall. The stomach contained fecal matter, and $5\frac{1}{2}$ inches from the pylorus there was a perforation by which it communicated with a large fecal abscess in the left hypochondrium and lumbar region, behind the peritoneum. The colon was normal up to $2\frac{1}{2}$ inches below the splenic flexure, where its outer wall was wanting, and the bowel thereby opened into the fecal abscess. A fistulous track, as large as the forefinger, led from the abscess downwards behind the peritoneum to the pelvis, where an ulcer of the rectum had perforated and caused the initial extravasation of fecal matter, which had thus spread in an upward direction.

¹ Brit. Med. Journal, Jan. 20, 1883.

² Lancet, May 26, 1883, and Med.-Chir. Trans., vol. lxvi.

³ Med. Times and Gazette, Nov. 1879, p. 603.

⁴ Lancet, July, 1883, p. 14.

Unfortunately, the diagnosis and relief of these conditions when situated high up, are not as easy as in the case of an ischio-rectal abscess; the mischief is often terribly far advanced before its cause is even surmised, and death ensues from septic absorption, hectic, or peritonitis. When a fecal abscess has been recognized and properly treated, by laying it open, irrigating, and draining it—or when it has spontaneously ruptured into the bowel or bladder—the prognosis must largely depend upon the cause of the extravasation. If due to simple ulceration, to violence, or to suppuration the result of violence, and beginning outside the bowel, there is hope of recovery, even without a permanent fecal fistula. On the other hand, if the extravasation have originated in cancer or tubercle; from complicated adhesions resulting in obstruction; from some disease behind the peritoneum, such as caries of bone, pancreatic calculus, or wide-spread suppuration in the cellular tissue arising from some inveterate disease of the uterine appendages, there is no probability of recovery. The destructive processes will continue and extend, and though death may come slowly, it will come surely, from blood-poisoning, exhaustion, or acute general peritonitis, due to the bursting of the abscess into the cavity of the peritoneum. It is unnecessary to dwell upon the various symptoms which may arise, and the differences which occur in fecal extravasations, as these resolve themselves into the symptoms of retro-peritoneal abscess.

Pus is sometimes extravasated into the retro-peritoneal tissue from some neighboring part, such as the pleural cavity, the sheath of a muscle, a hepatic, renal, or cystic abscess, etc., or from beneath the periosteum of a carious bone. But though in these cases suppuration does not originate in the retro-peritoneal cellular tissue, yet when once there, it lights up fresh suppuration, and, therefore, purulent extravasation may fitly be considered under the head of retro-peritoneal suppuration.

In fact, all forms of extravasation are liable to excite retro-peritoneal suppuration, but the probability of their doing so varies. Thus, whilst the tendency of blood to become absorbed, is, in comparison, considerable, and its tendency to break down and cause suppuration but slight; the tendency of urine to be absorbed is slight, and to excite suppuration considerable; whilst extravasated feces will surely provoke suppuration, though sometimes only to a limited extent, and in the form of a small fecal abscess with thick surrounding walls, instead of in a diffused manner and over a large area.

RETRO-PERITONEAL SUPPURATION.—*Causes.*—Retro-peritoneal suppuration may arise from blows and wounds, and other forms of external violence; from sprains of muscular or fibrous tissues; from cold, and various conditions of the blood, such as occur in fever; and from all the forms of retro-peritoneal extravasation and their causes. Necrosis of the ribs, vertebrae, sacrum, or innominate bone; suppuration of the retro-peritoneal lymphatic glands; the burrowing of pus through the foramina of the pelvis in hip-joint disease, from an abscess of the liver, gall-bladder, pancreas, or spleen, or from an empyema or pulmonic abscess, may each give rise to it. Suppuration about a stricture of the œsophagus, or within the pelvis of the kidney, whether from impacted calculus, cancer, or tubercle; the rupture of a renal cyst; hydatids; and disease of the uterus or its appendages, of the bladder, or of the intestine, have each their share in its causation. Ulcer of the duodenum should be specially mentioned, and so might ulcer of the rectum, typhlitis, and perityphlitis. Operations about the urethra, prostate, bladder, rectum, scrotum, testis, and spermatic cord, are prone to excite retro-peritoneal suppuration, on account (1) of the sub-peritoneal connective tissue; (2) of the venous connections of these parts; and (3) of the associate nervous influences.

Lastly, puerperal inflammations are frequent causes of widespread suppuration in the cellular tissue of the abdomen, as well as of the pelvis.

Symptoms.—These vary according to the cause and situation of the suppuration, and as to whether it is acute or chronic in character. They closely resemble the symptoms which are caused by the localized suppurations within the peritoneal cavity. The acute form begins with febrile symptoms—rigors, high temperature, quick pulse, loss of appetite, intense thirst, frequent sickness, headache, and constipation; followed by night sweats, great weakness, and pain and tenderness in the affected region, which any movement and some positions of the body aggravate; the countenance assumes a pinched, anxious, sallow, and sometimes a cadaveric expression; emaciation becomes extreme; and the abdomen gets hard, swollen, painful, and tympanitic. Local peritonitis is apt to arise, and septicæmia or pyæmia to set in.

Chronic or subacute suppuration commences very insidiously; the abscess may take years to form, and it often proceeds far before the symptoms are sufficiently pronounced to lead to an accurate diagnosis. There are a feeling of malaise, with more or less dyspeptic troubles; obscure rheumatic pains; a sensation of fulness, or aching, with, perhaps, an ill-defined tumor in the affected region; and some tenderness on deep pressure. Possibly the most marked symptoms, for a time, may be the ordinary indications of spinal disease; or simply some œdema of one leg or foot, of some part of the abdominal wall, or of the scrotum or vulva; or a pain felt along the course of one of the nerves which traverse the abdominal or pelvic wall, such as the ilio-inguinal, ilio-hypogastric, external cutaneous, or obturator, or a feeling of numbness along the course of one of these nerves. If the suppuration be in the pelvis, and especially if connected with the left broad ligament, a tense constriction may form about the rectum, and give rise to the symptoms of stricture of that part; or the only marked symptom may for a time be an abundant discharge of mucus, suggestive of dysentery or obstinate diarrhœa.

As suppuration becomes more established, the evening temperature keeps high, night-sweats occur, and the symptoms generally are more like those of the acute form. Pain and irritative fever may be severe, redness and œdema of the overlying skin are noticed, and gaseous crepitation in the underlying tissues may be detected—as in a case lately under my own care, in which an abscess pointed above Poupart's ligament, was very crepitant, and when opened gave exit to most stinking pus, and in which a drainage tube could be passed far inwards to the pelvis; œdema of the scrotum was also a very noticeable feature in this case.

There is often more or less disturbance of the viscera in the immediate vicinity of the disease; so that retro-peritoneal inflammation resembles disease of the organs within the peritoneal cavity which sympathize in the external inflammation. Thus we find that suppuration around the cæcum, or the sigmoid flexure, simulates inflammation of those parts; constipation and distension arise from suppuration around the ascending or descending colon; indigestion, flatulence, or gastrorrhœa and acute dilatation¹ of the stomach, may be caused by an abscess behind the duodenum; pleurisy or pleuro-pneumonia may be caused by an abscess below the diaphragm, or about the upper part of the kidney, liver, or spleen; jaundice may appear, and abscess of the liver be suspected, from suppuration behind the liver; and empyema, hydatids, disease of the spleen or gall-bladder, renal or spinal affections, ovarian or uterine disease, may, according to the part of the retro-peritoneal connective tissue most involved, be simulated by or mistaken for suppuration outside the peritoneum. Occasionally, a large abscess cavity is

¹ C. Hilton Fagge, Guy's Hosp. Reports, 3d series, vol. xviii. p. 4.

formed in the lumbar and iliac regions, limited in front by the colon and cæcum, or sigmoid flexure, and behind by the lumbar and iliac fasciæ; the nerves of the lumbar plexus may be dissected out from the place where they leave the spinal canal, and lie loosely in the suppurating space; the iliac vessels or the vena cava, lying to the inner side or in front of this cavity, may become ulcerated, or may slough, and sudden death from hemorrhage may occur. When such an abscess has already opened into the bowel, the blood has been known to hurry through the suppurating space, and, finding its way into the gut, to be discharged in large quantities through the anus.¹ Dr. Goodhart has related to me the following very interesting case:—

A military officer had, for a year or more, occasionally experienced difficulty in swallowing, and at these times required a quantity of fluid to “wash his food down.” He at these times emaciated rapidly, losing a stone or two in weight, but as quickly recovered as soon as the attack passed off. In the intervals, however, he often suffered pains about the epigastrium, and had a sense of distension after eating. On several occasions he had had shivering and feverish attacks like ague, and as he had been in the Ashantee War, it was supposed that they were due to some malarial influence, and that his liver might be affected. On one occasion, as he was about to leave his house, he felt a sudden faintness, and pain in his epigastrium, and vomited a little blood; the vomiting of blood was several times repeated, and within a day or two he was dead. A post-mortem examination revealed ulceration about a syphilitic thickening of the œsophagus, close to the stomach; this had set up suppuration in the surrounding tissues, and pus had burrowed behind the diaphragm, and had caused ulceration into the aorta, close to the celiac axis.

In other cases, the pus strips up the peritoneum as it spreads, and sets up local peritonitis, leading to adhesions of the omentum and small intestines, to thickening of the capsules and walls of the viscera, or to intra-peritoneal suppuration; or thrombosis of the renal, iliac, or pelvic vein, or even of the vena cava, arises, and causes great œdema of the parts below, which send their blood back to the heart through these channels. In some chronic cases, the abdomen may be gradually enlarged by the increasing pus until the swelling simulates ascites. Mr. Barton has recorded a case² in which spinal caries led to a large retro-peritoneal abscess; dulness extended from ribs to pelvis on one side, and up to the median line in front, the intestines being pushed over to the opposite side; and the abscess pointed as far forwards as a line on a level with the anterior border of the axilla.

Diagnosis.—In the subacute or chronic cases, and even in the acute form, whilst pus is confined beneath the fascia of the abdomen or pelvis, there is much difficulty in the diagnosis. We must, by a careful investigation of the history and of all the circumstances of the case, take pains to estimate how much of the symptoms is due to mere sympathetic participation in, or secondary affection of, the pelvic or abdominal viscera, and how much to the retro-peritoneal mischief. The excretions must be carefully examined, the functions of each organ inquired into; and by a thorough scrutiny of the symptoms, on the principle of exclusion of diseases, we shall eliminate renal, spinal, hepatic, splenic, intestinal, vesical, uterine, and ovarian affections. When pus is being discharged in the urine, or by the lung or œsophagus, it may be difficult, if not impossible, without a very careful study of the chronological order of symptoms, to determine the correct relationship of the retro-peritoneal suppuration and the visceral affection, so as to say which is the cause of the other.

Prognosis.—If the pus makes its way to the surface, and is spontaneously

¹ Numerous cases illustrating some of these points are to be found in Dr. Habershon's work on Diseases of the Abdomen.

² *Lancet*, March 17, 1883, p. 453.

discharged or evacuated through an incision, recovery ensues, unless blood-poisoning, hectic, or exhaustion carries off the patient. Sometimes the matter burrows far and wide between the muscles of the abdominal wall, or along the psoas and iliacus to the groin, or out through one of the foramina of the pelvis; or it may spread upwards to the diaphragm, or above it to the pleural or pericardial cavity; or between the great vessels in front of the spine and the prevertebral plexuses and cords of the sympathetic; or inwards to one, or other of the hollow viscera; or through the peritoneum into the cavity of the abdomen or pelvis. An abscess in the pelvis may discharge into the rectum, vagina, or bladder, and be followed by recovery; or death may ensue from extensive and complicated burrowing and its consequences. A case was under the care of Dr. Coupland, in the Middlesex Hospital, in which, at the post-mortem examination, extensive suppuration was found in the pelvis, having been started by inflammation of the ovary; and the matter having burrowed beneath the peritoneum, ulcerated into the rectum and also into the bladder; it had also spread along the psoas, and discharged in the groin, and again had burst into the bowel at a higher point. Suppuration about the kidney may burst into the colon, pelvis of kidney, or peritoneum, or may take one of many directions. Thiersch had a case of perinephric suppuration, which by extension in one direction had caused empyema, and in the other a sinus on the front of the thigh. When the iliac region is chiefly affected, recovery may ensue after rupture into the cecum or sigmoid flexure, or death after the matter has burst into the peritoneum. In cases in which suppuration has originated in disease of the vertebral column, the pus may open into both the colon and lung, so that it is both expectorated and voided with the feces. Even such cases are not always fatal, but recovery may ensue after a tedious convalescence, either with or without the establishment of a fistula.

Treatment.—When inflammation or suppuration is known to exist, the treatment is, fortunately, quite clear, even though for a time a precise diagnosis as to the exact structures affected is impossible. Rest, leeches, warm sedative applications, attention to the digestive organs, the avoidance of sources of irritation to the bowels and kidneys, and of all unnecessary action or straining of the abdominal muscles, are necessary in the early inflammatory stages, whether the disease be external or internal to the peritoneum. When suppuration has taken place, the sooner a free vent is made for the discharge the better. There should be no delay in evacuating and freely draining a retro-peritoneal abscess, from whatever cause it has originated, or wherever it may be situated, more especially if the constitution is suffering from the pent-up matter. In all cases the pus should be let out through an external opening, if possible; but when it is distinctly pointing towards the rectum or vagina, no hesitation should be felt in making an opening through their walls. In very many cases the pus can be withdrawn through an aspirator. This instrument may have to be used again and again, at intervals of days or weeks, and ultimately a cure may result; or it may fail, and a cure will only be obtained by a free opening. I have had successful results with the aspirator in psoas abscess, after three and four aspirations, and I know of one case which was permanently cured after seventeen aspirations, lasting over a period of eighteen months. If the aspirating needle gets blocked with flakes of lymph or pus, it has been recommended to inject through it a drachm or two of tincture of eucalyptus, which is to be left in the abscess for a few days. It is stated that the flaky matter, by the solvent action of the eucalyptus, becomes fluid, and can then be easily withdrawn through the needle. In a large number of pelvic and iliac abscesses, an incision above Poupart's ligament, followed by free drainage, will bring about a cure; and lumbar abscess heals

after an incision in the back. Mr. Frederick Treves, in a valuable paper read before the Royal Medical and Chirurgical Society of London, in January, 1884, has lately advocated an incision along the outer edge of the erector spinæ muscle in the treatment of psoas abscess and retro-peritoneal suppuration resulting from caries of the spine. By cutting through the sheath of the erector spinæ, and the quadratus and psoas muscles, the vertebræ are reached, and the anterior surface of the bodies of all the lumbar vertebræ can be explored. Mr. Treves details three cases in which the operation was followed by complete recovery, and in one of which a large sequestrum, measuring one inch by half an inch, was removed from the body of the first lumbar vertebra. Retro-peritoneal abscesses having a spinal origin may be treated in the same way.

I have found healing hastened, in some cases, by making the patient wear a Thomas's hip splint, so as to keep the thigh and trunk in line and prevent the action of the psoas and iliacus muscles; moreover, with this splint on, the patients are able to stand and move about, and thus the viscera are brought to bear upon the iliac and pelvic fasciæ, and tend to keep the abscess-surfaces in contact. A marked case was under my care two years ago, of extensive sub-peritoneal suppuration in the pelvis and left iliac fossa of a woman; free incisions and drainage above Poupart's ligament resulted in fistulæ, which would not close. For seven months a free purulent discharge continued unabated, the patient being meanwhile kept in bed; then a Thomas's splint was applied, and she was allowed to get up; in six weeks the abscess had completely dried up, and the fistulæ closed; but for four or five months the splint was worn to check the action of the ilio-psoas muscle. The patient has remained well since.

In some cases it would be best no doubt to make an abdominal incision, open and cleanse the abscess cavity, and stitch the edges of the incision into the abscess to the edges of the parietal wound. This has been done with marked success by Mr. Lawson Tait,¹ in twenty cases of suppurating, extra-peritoneal pelvic hæmatocles, and there is no reason why the same treatment should not be applied with good results to many other cases of retro-peritoneal suppuration. The evacuation of pus by abdominal section would not be difficult, and, as compared with the risks of leaving such abscesses unopened, not dangerous; whilst rapid recovery would follow if the general cavity of the peritoneum were protected in the way suggested and practised by Mr. Tait. After pus from these retro-peritoneal abscesses has commenced to discharge, the strength of the patient requires to be maintained by tonics, nutritious diet, and stimulants; careful dressings and scrupulous cleansing of the wound, and attention to the condition of the bedding must be observed, so as to avoid bedsores and blood poisoning. As soon as possible the patient should be taken out of doors, and passive exercise in the fresh air encouraged. Even the daily change of room is advantageous in these, as in all other forms of purulent discharge. As the stench from some of these retro-peritoneal abscesses is very sickening and offensive, means should be taken to deodorize the discharges, and dressings of an antiseptic character should be used. I know of nothing more efficacious in correcting the condition of ill-smelling discharges, and in substituting a healthy odor in its place, than iodoform applied on lint, and in some cases covered over with the thinnest film of cotton-wool, so as to prevent contact of the drug with the skin or wound.

RETRO-PERITONEAL ASSOCIATED WITH INTRA-PERITONEAL ABSCESS.—Retro-peritoneal abscess may set up, or be set up by, or have a common origin and

¹ *Med.-Chir. Trans.*, vol. lxxiii. p. 307; and *Diseases of Ovaries*, 4th ed., p. 344.

communicate with, localized collections of pus within the cavity of the peritoneum. This association is, perhaps, especially seen in that form of retro-peritoneal suppuration which originates in ulceration and perforation of the duodenum; but it occurs also from other causes and in other parts. An illustrative case was admitted under the care of Dr. Cayley into the Middlesex Hospital:—

A draper's assistant, aged twenty-six, had enjoyed good health with the exception of a severe attack of epigastric pain about one year before admission. This had invalidated him for six weeks. Six days before admission he was seized with acute pain in the stomach, which prevented him from walking home; it lasted all night, but abated in the morning, when he went to business again. In the evening, however, the pain recurred, and continued. The bowels were constipated, and he was sick. On admission, he had acute pain across the belly, and in the right iliac region; the abdomen was very tender, especially in the epigastrium, where there was considerable fulness also. A distinct resistance was felt in the right iliac fossa, which was dull on percussion; elsewhere the abdomen was tympanitic. In the course of a few days empyema and pneumothorax of the right side developed; an opening into the pleura was made, and was followed up by removal of a part of the eighth rib; sloughing spread upwards to the neck, and downwards to the crest of the ilium along the right side of the back; and death ensued within a month from admission. At the post-mortem examination, the edge of the right lobe of the liver was found adherent to the parietal peritoneum, and there was an abscess-cavity containing fetid gas, and about three ounces of purulent fluid. This cavity was limited on the inner side by the suspensory ligament of the liver, above by the diaphragm, and below and behind by the liver. It had two openings, one of which communicated with the duodenum, one inch from the pylorus, on its posterior wall, by a sinus one and one-half inches long which just admitted a probe, and which passed inwards to the gut beneath the edge of the liver. The transverse colon was firmly adherent to the liver and parts around, and helped to form one wall of this sinus. The other opening admitted a No. 12 catheter, was on the upper and outer aspect of the sac, on a level with the seventh rib, and connected the abscess-sac with the right pleural cavity. The walls of the sac were thickened, opaque, injected, and covered with false membrane. It had evidently existed a long time. There was general peritonitis. The right chest contained offensive pus, and the pleura was covered with greenish colored lymph. The opening into the chest between the seventh and ninth ribs communicated with the sloughing retro-peritoneal tissue in the back.

The clinical history of this case, read by the light of the post-mortem examination, points to ulceration of the duodenum as the cause of the suppuration in the cellular tissue behind that part of the bowel; and this in turn excited inflammatory adhesions about the colon, and inside the peritoneum, and the abscess-sac above described. All this took place in the illness twelve months before death; then came the fresh attack, which led to the bursting of the intra-peritoneal abscess through the diaphragm, and thus to the fatal empyema. In other somewhat similar cases, death has arisen from bursting of the abscess into the pericardium or peritoneum.

FATTY TUMORS OF THE ABDOMINAL CAVITY.

A few cases of fatty tumor of large size, occupying a considerable part of the abdominal cavity, have been recorded. The London Pathological Society's Transactions contain three such, and in the *Lancet* for 1883, one was reported. They grow slowly and painlessly for a long while, but at length by their bulk cause abdominal tenderness, with loss of flesh and of appetite, and produce pressure upon vessels and viscera of the abdomen. They have been known to undergo both fibrous and osseous degeneration; and their removal during life has been attempted. They appear to grow from the peritoneum,

are encapsuled, and have no connection with the surrounding organs. Their connection is sometimes with the back of the abdomen, where they fill the hollow on each side of the lumbar spine, and pass upwards and downwards from these localities.

They have no special symptoms. When of large size, and causing thereby trouble or danger, an attempt should be made to remove them by laparotomy.

GASTRIC FISTULÆ.

Gastric fistulæ include fistulæ of the stomach opening into other hollow viscera, as well as those which open externally, and which, therefore, may properly be called gastro-cutaneous.

They may be divided into those which are the result of mechanical injury, and those which arise from disease. There are at least four kinds of mechanical injury which are known to have produced the external fistulæ, to which we here specially refer: 1, Incised, punctured, or lacerated wounds of the abdomen, penetrating the stomach. 2, Gunshot wounds, the shot either directly penetrating the stomach, and at once giving rise to the fistulous opening—as in the celebrated case of Alexis St. Martin, whose accident occurred in June, 1822, and who was known to be still alive and well, but with his fistula still unclosed, in 1873—or the fistula being subsequently established by the sloughing of the part of the wall of the stomach in contact with the wounded parietes, as in the case of Maillot, reported by Baron Percy,¹ and as in three cases recorded in the History of the War of the Rebellion,² in which the fistula followed the wound at periods varying from two to seven weeks. 3, A blow over the stomach, which, by causing an abscess in the parietes, has led to adhesion of the stomach, and in time—varying from a few weeks to several months—to a fistulous opening, the abscess-walls giving way both into the stomach and externally. 4, Ulceration from external pressure, as in the celebrated, self-inflicted fistula of Catherine Ross.³ Though there are cases on record of knives and other foreign bodies, which, having been swallowed, have escaped, by forming abscesses, through the abdominal walls, it appears that the opening rarely becomes fistulous; and probably the wound in the stomach heals in some of the cases before the abscess opens externally. In one case,⁴ however, the prong of an iron comb set up ulceration from within, and led to a gastric fistula.

Of the diseases which cause gastric fistula, only two are known, namely, cancer, and simple perforating ulcer of the stomach, either of which may give rise to it: (1) by gradual and continuous extension of the ulcerative process through the part of the abdominal parietes to which the affected portion of the stomach has become adherent; or (2) by first exciting around the ulcerated area a circumscribed abscess, which ultimately discharges its contents through the abdominal wall. The latter is, perhaps, the commoner mode; and as abscesses in the liver and in the abdominal parietes sometimes break into the stomach, it has been thought possible that some of the cases which have been described as simple gastric ulceration, may have originated in abscesses, which have opened externally as well as into the stomach. Fistulæ from disease are rarely seen in men, but nearly always in women. According to Murchison, gastro-cutaneous fistulæ are twice as frequently the

¹ Journal de Médecine, t. iii. p. 510. 1802.

² Op. cit., Part II., Surg. Vol. pp. 52–53.

³ Reported by Dr. C. Murchison, Med.-Chir. Trans., vol. xli. p. 11.

⁴ Med. and Surg. Hist. of War of Rebellion, Part II., Surg. Vol. p. 53.

result of simple ulcer as of cancer; this is the reverse of what has been found in gastro-colic fistula.

There are fistulæ which simulate the gastro-cutaneous; thus in Streeton's¹ case of multiple ulcer of the duodenum, immediately beyond the pylorus, food escaped as soon as it had been swallowed, from the external opening situated between the seventh and eighth ribs of the right side, just below the right mamma. In a specimen in Charing-Cross Hospital Museum, there is to be seen a specimen of cancerous stricture of the colon, with a communication between the duodenum and colon above the stricture, and another, through the abdominal parietes, with the surface near the umbilicus. In this case any fluid taken into the stomach passed at once from the duodenum into the colon, and thence within a few minutes to the surface.

The situation of the external opening depends, in traumatic cases, upon the situation and obliquity of the wound; in St. Martin's case it was between the left ribs, portions of which had been removed by the shot, and in Percy's case (Maillot) it was close to the ensiform cartilage; in Keith's case (Catherine Ross), the opening, which was transversely oval, was situated in the epigastric and upper part of the umbilical regions.

In cases resulting from disease, the place of external opening depends somewhat on the region of the stomach in which the ulcer commences; thus if the disease is near the pylorus, the external opening is generally near the umbilicus; if the ulcer is on the anterior surface, or near the fundus, the opening will be in the epigastric, or in the left hypochondriac region. The margins of the opening are generally hard and rounded; but when the fistula is caused by cancer, ragged or even gangrenous; sometimes the orifice is deeply retracted, so that it looks like a funnel. The skin around the fistula is usually red, tender, and even excoriated, owing to the irritation of the discharges. The size of the opening varies from something less than an inch to one and a half or two inches; in Catherine Ross it was four inches by three. It does not always remain of the original size: in some cases it increases; but generally, when there is a tendency to vary, it is towards narrowing. Upon the size depends whether the solid as well as the fluid contents of the stomach escape: if the opening is very small, fluids only pass out; otherwise, whatever is swallowed escapes, unless some artificial contrivance prevents it.

Symptoms.—It is remarkable how little the general health is affected by the fistula. The principal effects which have been recorded are thirst, increased appetite, obstinate constipation, deficient secretion of urine, and amenorrhœa. These symptoms are mostly traceable to the escape of ingesta from the wound, whereby thirst and hunger are excited, and the material which goes towards forming feces and urine is diverted from its proper channel. The fecal matter of these patients has in several instances been like the droppings of sheep, and only one stool has been passed in three, four, or even twelve days. The sense of hunger has sometimes amounted to actual pain. Vomiting appears to have been quite exceptional.

Prognosis.—In not a few instances patients have lived for many years with an open gastric fistula; in twelve out of twenty-five cases which Murchison collected from the records of Medicine and Surgery for 300 years, the fistula and existed for varying periods, from three years upwards. The length of time that a person may live with a gastro-cutaneous fistula depends on its cause; if due to cancer, the duration of life is of course short, from three weeks to several months; but if due to a simple ulcer, or to a wound, it may last for years. Though wounds of the stomach are mostly fatal, recovery occasionally occurs, either with or without fistula. A traumatic fistula may last a

¹ Lond. Med. Gazette, vol. iii. p. 43. 1829. (Case XVI. in Murchison's list.)

few months, and then close; or it may last as long as the patient lives—cases of four, eight, ten, and even fifty years' duration are recorded. The fistula caused by a simple ulcer may close up spontaneously and permanently; or, having closed, may re-open after a time; or may remain permanently open, and the patient live for seven, nine, twelve, or thirty years.

Treatment.—Although in several of the recorded cases the fistula has closed spontaneously, in only two out of twenty-five instances collected by Murchison does closure seem to have been the effect of treatment. In one of these, a fistula of ten years' duration was closed by making the patient keep quiet in her bed for some weeks. In the other, a cure was effected by keeping the edges approximated by means of the gradually increased compression of a circular bandage, feeding by the rectum, and preventing contact of the escaping contents of the stomach with the surrounding skin.

The indications for treatment are: (1) To prevent if possible the escape of the injecta. This is to be done by the use of a suitable, flat compress; not a plug, which does not effectually answer its purpose, whilst it tends to enlarge the opening. (2) To keep the surrounding integuments clean and as free from irritation as possible. To this end careful washing and drying, followed by the application of zinc ointment, of oxide of zinc in powder, or of oiled lint around the opening, are essential. (3) To encourage granulation and cicatrization of the edges of the wound by the occasional use of a stimulating application, and to make them approach one another as near as possible by the use of some well-adjusted, compressing bandage. In the case of Alexis St. Martin, the necessity of any compress to prevent oozing was after a time obviated by a slight protrusion of the coats of the stomach, and in other cases a similar natural plug has been formed. In no known case, except Middeldorpf's (1859), has any operative procedure succeeded. I can, however, see no objection to the proposal to attempt in suitable cases to close a gastric fistula by a flap of skin dissected off the neighboring part of the abdomen, turned with its cuticular surface inwards, and nicely fitted to the orifice, whose edges should have been previously freshened. No such attempt should, however, be made until nature's efforts have failed; and to facilitate union if such an operation is performed, the patient must for many days be fed by the rectum. It is to be feared, however, that the contact of the gastric juice may interfere with primary union, whilst there is the risk of perchance exciting interstitial inflammation in the coats of the stomach.

BILIARY FISTULÆ.

EXTERNAL OR CUTANEO-BILIARY FISTULÆ are the result (1) of gunshot wounds. In some cases the shot has passed right through the liver and penetrated the parietes in two places, bile afterwards issuing from one of them; in other cases the shot has been buried deeply in the liver-substance. (2) Blows over the liver lead to adhesions between that organ and the parietes, and then to abscess either in the parietes or in the liver itself. After the incision or spontaneous bursting of the abscess, a fistula results. (3) Hepatic abscess of non-traumatic origin may point and open at any part of the parietes with which the liver is in contact. These openings often heal, but in some cases a gangrenous ulceration of the parietes of the abdomen follows and keeps the fistula open. (4) Gall-stones sometimes, after leading to adhesions of the gall-passages, are discharged externally. The gall-bladder is usually the part of the biliary system thus affected. Yet after the discharge of several faceted gall-stones through the umbilicus, I have known the fistula to be only temporary; the patient was a young woman in the practice of Mr.

Morris, of Petworth, and quite recovered. Murchison¹ collected 70 cases of biliary fistula having this origin, though the situation of the external opening was not the same in all cases. The number of gall-stones discharged by the fistula has varied from one to six hundred; when there is only one, it may be as large as a hen's egg, but when there are several they are usually small and smoothly faceted by attrition. The calculi may be discharged almost as soon as the opening is formed, or not for years afterwards. (5) Distension of the gall-bladder with purulent or muco-purulent matter may lead to adhesion, and the subsequent discharge of the contents externally. A typical case of this sort is to be found in the Philosophical Transactions for August and September, 1738,² entitled, "An obstruction of the biliary ducts and an impostumation of the gall-bladder discharging upwards of eighteen quarts of biliary matter in twenty-five days, without any apparent defects in the animal functions." Four months before death jaundice came on, followed by pain in the right hypochondrium and an inflammatory tumor, which went on to suppuration, the abscess being opened with a lancet. On post-mortem examination, a large sac was found shut off from the general peritoneal cavity, and communicating with the gall-bladder which was itself distended.

The fistula may communicate with the liver-substance, with the gall-bladder, or with one of the larger bile-ducts: when the result of injury, it is more frequently with the liver; when the result of disease, it is commonly with the gall-bladder. The external opening may be over the fundus of the gall-bladder, to the left of the median line, in the inguinal region, in any part of the right hypochondrium, or at the umbilicus. To the umbilicus it is directed by the suspensory ligament of the liver.

Dr. Burney Yeo has recorded a case in which over one hundred gall-stones were spontaneously discharged through a fistula in the hypogastrium five inches below the umbilicus.

A case is published in the Gazette des Hôpitaux,³ in which two biliary calculi were removed from above the clitoris, where they were encysted in the subcutaneous tissue. In one case, where the lung as well as the liver had been wounded by the same shot, the fistulous opening was below the scapula on the right side; in another case it was at the lower part of the sternum on the left side; and in a case described by Hennen, it was between the eighth and ninth ribs on the right side, two and a half inches from the spines of the vertebræ. The fistulous channel may be many inches long, and very circuitous in its course. In rare cases there are two or more openings at a distance from one another.

Symptoms.—The discharge from these fistulæ is not always pure bile. More frequently, perhaps, it is pus, or muco-pus; or these mingled more or less largely with bile or blood. The daily quantity which drains away has been found to vary from eight ounces to two pints. If the cystic duct is obstructed, no bile can flow by the fistula; if the common duct is occluded, the jaundice which precedes the fistula generally disappears after an opening is established, though even then no bile will pass off by the bowel; in rare cases the gall-ducts are patent, and bile escapes both by the fistula and with the stools. When the amount of bile lost is great, the patient rapidly loses flesh and strength, and dies marasmic. During the formation of a fistula due to gall-stone, there is often great suffering, especially whilst the calculus is passing and biliary matter is accumulating behind it; but the patient will soon recover, and may enjoy good health long before the fistula closes. Indeed,

¹ Lectures on Diseases of the Liver.

² Op. cit., vol. xl. p. 317.

³ Loc. cit., 8 Oct., 1846.

the formation of the fistula, by giving exit to calculi, may give permanent immunity from similar periodic attacks of hepatic colic and jaundice, which have occurred during a course of many years.¹ When the cause of a fistula is a wound, there will be the attending symptoms excited by the injury; when the cause is disease, there will be those attributable to it.

Prognosis.—The duration of biliary fistulæ varies. In many of the cases of recovery after stabs or gunshot wounds, there has been a temporary fistula for from several days to several weeks, and then perfect closure has occurred.² In other cases the patients have lived for several years in more or less impaired health, with purulent and bilious matter constantly discharging from the fistula. When the cause of the fistula is gall-stone, it usually soon closes after all the calculi have come away, but it has been known to keep discharging for many months. When the calculi are numerous, and the fistula long and tortuous, the opening has continued for years—in some instances showing every now and then a tendency to close, but again and again opening to allow the escape of other calculi.

The fistulous openings are chiefly serious on account of the inconvenience they occasion. In a large proportion, when due to disease, the patients live for years in fair health; and in many instances the fistula closes altogether. Complete healing may be looked for in cases of gall-stone, if the calculus is single, if the opening is directly over the gall-bladder, if the discharge is free from bile, and if there is no jaundice. The most unfavorable cases are those in which the fistula is due to cancer, or to abscess in the parenchyma of the liver. Those cases in which the cystic duct is patent and the common duct obstructed, must result in a permanent discharge of bile, and marasmus sooner or later must ensue.

Treatment.—No general rule can be laid down for the management of these cases, except that which is common to all external fistulæ, namely, to keep the opening and the structures around it scrupulously clean and free from irritation. But little can be expected from operative attempts to close the fistula, though if the common bile-duct be patent, and the patient much debilitated by the continual loss of bile, the question of making the effort may properly be considered; but if, owing to obstruction of the common bile-duct, the bile cannot enter the bowel, there is no chance of success, and every reason for not undertaking the operation. If a calculus plug the fistula and lead to abscess, or to the accumulation of discharge; or if a calculus can be felt lodged near the orifice, it will be necessary to open up the fistula and extract, or at least facilitate the escape of, the calculus. This operation has often been successful, but it should be done with care, because there are several cases which prove that even the introduction of a probe or dressing forceps may induce fatal peritonitis. In some cases it will be right to lay open the gall-bladder and remove its contents; and there are grounds for thinking that a permanent fistula may in some cases be prevented, and in others cured, by the operation of cholecystotomy. When there remain behind one or more biliary calculi, the fistula should be kept open with the hope that they will escape through it at some future day.

INTERNAL BILIARY FISTULÆ.—Besides the external fistulæ, a variety of fistulous communications occur between the biliary passages and adjacent organs—such as the stomach, duodenum,³ and colon, by a process of ulcera-

¹ Lancet, March 11, 1882, p. 391.

² Guthrie's Commentaries, etc., 6th ed., pp. 582-584. 1855.

³ Murchison has collected twenty-eight such cases, and in the majority of them death was caused by obstruction of the small intestine by a large biliary calculus, though in several a large calculus was passed *per anum* after the symptoms of obstruction had existed.

tion or gangrene set up by gall-stones within the gall-bladder or bile-ducts. M. Fauconneau-Dufresne¹ has collected cases of fistula between the gall-bladder and pelvis of the right kidney, vagina,² and portal vein.³ Dr. Cayley⁴ has reported a case in which, in consequence of the impaction of a stone in the common duct, a fistulous communication was formed through the diaphragm between the left pleural cavity and a cystic dilatation of one of the bile-ducts in the left lobe of the liver.

Murchison⁵ in one instance found the gall-bladder communicating with the duodenum, the colon, and the external surface; and Bristowe⁶ found the common bile-duct communicating with the colon, the duodenum, and the portal vein. Dr. Coupland met with a case in the post-mortem room at the Middlesex Hospital, in which a number of biliary calculi, varying in size from that of a millet-seed to that of a poppy-seed, were found in distinct groups outside the gall-bladder, encysted in peritoneal adhesions. The case is of interest, as showing that calculi may escape from the gall-bladder or passages into the peritoneal cavity, without necessarily exciting fatal peritonitis.⁷ Cystico-colic fistula is usually associated with cancer of the gall-bladder, but it may be simple. Cystico-duodenal fistula is likely to lead to impaction of the calculus and obstruction of the bowels. The opening is generally situated in the third part of the duodenum. In cystico-gastric fistula the opening will probably be found close to the pylorus. Cruveilhier was of opinion that the fact of vomiting a gall-stone proved the existence of such a fistula. The symptoms of cystico-gastric and intestinal fistulæ due to gall-stones are usually slight and obscure; jaundice is rarely present, as the common duct is usually patent, and only occasionally is there a history of gall-stone colic with jaundice. Vomiting, with more or less colic, and tenderness in the region of the gall-bladder, are the commonest symptoms; hæmatemesis and bloody stools have been known. In cystico-urinary fistula the symptoms have been renal, not hepatic, but it must be remembered that cholesterine may be found in the urine though no such fistula exists.

URINARY FISTULÆ.

Urinary fistulæ are of many varieties, and might be classified, (1) as to the part of the urinary organs with which they communicate; (2) as to the part of the surface at which they establish an opening; (3) as to their causes; and (4) as to their characters, namely, as to whether they are simple, or callous, or attended with loss of tissue.⁸ Many of the forms of urinary fistula which arise, for example, from stricture or abscess of the perineum, I am not expected to describe here; and I shall therefore confine my remarks chiefly to those which open on the surface of some part of the abdomen, merely enumerating others which consist in a communication between some part of the urinary organs and the viscera within the cavities of the abdomen and pelvis.

FISTULÆ WHICH COMMUNICATE WITH THE KIDNEY AND PELVIS OF KIDNEY.—These may be caused (*a*) by incised, punctured, or gunshot wounds, (*b*) by injury inflicted during surgical operations, and (*c*) by disease. The records

¹ *La Bile et ses Maladies*. Mém. de l'Acad. Roy. de Méd., tome xiii. p. 341. 1847.

² *Ibid.*, p. 159. ³ *Ibid.*, p. 340.

⁴ *Trans. Path. Soc. Lond.*, vol. xvii. p. 161.

⁵ *Lectures on Diseases of the Liver*, p. 534, Case XCIV.

⁶ *Trans. Path. Soc. Lond.*, vol. ix. p. 285.

⁷ See *Trans. Path. Soc. Lond.*, vol. xxviii. p. 157.

⁸ See J. A. Jagielski, *De fistulis urinaris adjecta hujus morbi historia*.

of military surgery contain many examples of fistulæ caused directly by gunshot wounds of the kidney, or indirectly by the kidney becoming involved in the suppuration which follows gunshot wounds of the loins. Stabs, and incised and lacerated wounds in the back and loins, are sometimes followed immediately, or after an interval, by discharge of urine. Nephrotomy for hydronephrosis and pyonephrosis is likely to be followed by a permanent fistula, if the remnant of the kidney be not removed by nephrectomy. All traumatic renal fistulæ may be expected to close sooner or later. Abscess of the kidney, whether due to the irritation of a renal calculus or to tubercular or other form of renal disease, is a cause of urinary fistula in the loin, either by spontaneously bursting, or through the non-healing of the wound if the abscess have been opened by the surgeon. The discharge of pus and urine in such cases is often very obstinate, the wound contracting to a certain extent, and then remaining as a chronic, and sometimes even as a permanent fistula. A renal abscess may open into the colon, and has been known even to open into the stomach. In not a few cases in which the ureter has become blocked, the kidney or its pelvis, as well as the peri-renal tissue, have suppurated, an abscess has opened on the surface, and a urinary fistula has subsequently formed. McClelland, of Pittsburgh, records a case in which two fistulæ formed as the result of obstruction of the ureter by calculi: the first opened in the loin, and gave exit to a calculus, and a sinus continued; four years afterwards a second abscess formed, and was opened in the groin, giving exit to pus and urine. As the excretory function of the kidney remained, the woman's state became very offensive, and she was relieved by, and recovered from, lumbar nephrectomy. This operation has been performed no less than seven times for the relief of lumbar, abdominal, uterine, and vaginal urethral fistulæ, and in six cases with recovery.

Treatment.—The parts around the fistulous orifice must be kept clean and free from irritation and the contact of the discharges. Time should be allowed for the spontaneous closure of the fistula, and in many instances the surgeon will not be disappointed. If, however, the fistula persist, caustics, the hot iron, or an incision—so as to lay open any sinuous track, vivify callous surfaces, or remove spongy granulations or calculous deposit—must be tried. The injection of iodine solution, besides acting as a disinfectant, will sometimes stimulate the sinus to healthy action; dilute nitric and nitro-hydrochloric acid in solution have been tried, but without any marked effect. If a foreign body, such as a bullet, piece of bone, particle of clothing, or calculus, is keeping up irritation and preventing healing, it should be removed. If the other kidney be sound, and the fistula permanent, the best treatment is nephrectomy, and this operation should be practised in any case in which, other treatment having failed, the life of the patient is threatened, or his comfort sacrificed. It should, however, be borne in mind, that persons may live long and comfortably, and even in good general health, with a lumbar fistula; and that though for a long time urine may have flowed freely from it, the quantity of urine discharged may at length be greatly reduced, or the flow may even cease altogether.

FISTULÆ WHICH COMMUNICATE WITH THE URETER.—These are generally, if not always, the result of operation wounds. Excepting those cases in which the pelvis of the kidney has been the seat of rupture, I do not know of any instance of traumatic ureteral fistula other than as a result of surgical wound. The doubtful case recorded by Mr. Holmes,¹ subsequently received from the author another interpretation, namely, that it was a wound of the theca ver-

¹ Med.-Chir. Trans., vols. lx. and lxy.

tebralis. After prolonged and difficult child-birth labor, urinary fistula has arisen from sloughing of, or injury to, the ureter, and the fistula in some cases has opened into the uterus, and in others into the top of the vagina. In the removal of ovarian and uterine tumors, the ureter has on several occasions been divided, and it would have been well in these accidents if the renal part had been brought out through a wound made for the purpose in the loin of the same side, and its orifice there attached by sutures so as to be outside the peritoneal cavity.

Agnew¹ mentions a case in which the ureter was accidentally divided in removing an adherent ovarian cyst. The renal end was secured in the external wound, and a urinary fistula formed. The patient lived several months, and finally died of some obstruction in the course of the duct. The great objection to bringing such a long, cord-like structure out at the anterior abdominal wound, is lest it should be a cause of subsequent intestinal obstruction. It is quite possible to mistake, for the moment, the spermatic vein for the ureter. Once in removing an ovarian tumor, in a case which was complicated by numerous and difficult adhesions, a long, narrow tube tore away from the back of the cyst-wall; it looked like the ureter, and I traced it up to the right loin; further examination, however, proved it to be the ovarian vein. It has also happened to me on one occasion, when removing the entire uterus for cancer of the os and cervix, to cut out about half an inch of the pelvic end of the ureter, which was thoroughly incorporated in the diseased tissue about the neck of the womb. I turned the lower end of the part still connected with the kidney, into the vagina, and fixed it there, and then closed the opening in the peritoneum by sutures. The patient did not, however, recover from the shock of the operation upon the uterus, so that the result of the injury to the ureter could not be determined. In six² out of ninety-four published cases of extirpation of the uterus, one ureter has been divided; and in two other cases, both ureters. When the disease is seated in the cervix of the uterus, and the tissues around are infiltrated, this accident is often unavoidable, unless some of the tissue infiltrated with cancer is left behind. When the disease is quite in an early stage, and situated in the os or fundus, there is little or no risk to the ureter if care be taken. I have removed the uterus for early cancer of the os uteri, by the abdomino-vaginal method, without seeing or injuring either ureter.

It was for a urinary fistula of the ureter that the kidney was first successfully removed, the operation, as is now well known, being lumbar nephrectomy; and it was performed by Simon, of Heidelberg. Out of eight nephrectomies for urinary fistula, seven have been lumbar and one abdominal; the abdominal incision was made more externally or laterally than the linea semilunaris, and the operation was performed by Mr. K. Thornton. The cases in which large urinary cysts have formed and been tapped in the lumbar region, and which have been supposed to be due to wounds of the ureter,³ have been discussed in a previous section of this article. (See Wounds of Kidney and Ureter.)

FISTULÆ WHICH COMMUNICATE WITH THE URINARY BLADDER.—(1) *Vesico-abdominal Fistula*.—Wounds, gunshot and otherwise; sub-parietal rupture of the bladder; ulceration of the coats of the bladder from disease of its walls or from the pressure of a foreign body within the organ; and inflammation beginning in the peritoneum, pelvic cellular tissue, or ovary or other pelvic

¹ Principles and Practice of Surgery, vol. i. p. 376.

² Spencer Wells, Med.-Chir. Trans., vol. lxxv. p. 34.

³ Stanley, *ibid.*, vol. xxvii.

organ, are all causes of vesico-abdominal fistula, that is, of fistula opening externally upon some part of the abdominal wall, and communicating with the bladder.

(a) Dr. Otis¹ gives records of a number of very satisfactory recoveries after shot-wounds of the bladder. In several of them the missile traversed the distended bladder obliquely, passing in at the right or left side of the hypogastrium and out at the opposite buttock; in some instances the ball entered above the pubis; in one it passed in at the iliac fossa and perforated the fundus of the bladder on its way out at the opposite buttock. In some of these cases the wounds healed very rapidly, urine escaping from one or both orifices, but generally from the supra-pubic, for a short time, and the wound then closing without ultimate derangement of the function of the bladder. In others a troublesome urinary fistula remained for two or three years, and then permanently closed. In some cases the patients recovered, but with persistent urinary fistulae, the persistence of which was in several instances due to the presence of dead bone, though in others there was neither the presence of dead bone nor any other foreign source of irritation. Other patients are reported as recovering from recto-vesical fistulae from gunshot wounds, early in some cases, but in others the fistula remaining pervious for long periods. The learned historian of the War of the Rebellion remarks: "It is rare to find the functions of the bladder perfectly restored after shot injury."

(b) Stricture of the urethra may lead to ulceration of the parietes of the bladder, and this to an external fistula. Sir Benj. Brodie mentions that, in cases of old and neglected stricture, abscesses may form above the pubis, owing to vesical ulceration; and he adds that the surgeon may be deceived into fancying that the supra-pubic tumour is a distended bladder.

(c) Sir Prescott Hewett has described² a case of urinary abdominal fistula after rupture of the bladder. A man aged fifty-three suffered rupture of the bladder behind the pubis, and by the twelfth day afterwards three distinct tumors had formed in the lower part of the front of the belly. An incision was made into one in the left iliac region, and about three pints of fetid pus with large sloughs were let out. Urine afterwards passed through this opening. The man died on the twenty-third day.

(d) A foreign body may find its way from the bladder by ulceration, and lead to a fistula in the groin. An interesting case is mentioned by Sir Hans Sloane in his reply to the Marquis de Caumont, who had sent Sir Hans "a very remarkable stone taken out of a man's bladder after death." Sir Hans writes³ "I have likewise a common pin which by some means or other had got into the bladder of a young woman, and was there coated all over by a calculous matter; but having occasioned a fistulous ulcer in her groin, it was discharged thence with the matter of the fistula."

(e) In other cases a foreign body may ulcerate into the bladder, and likewise through the abdominal parietes, and thus give rise to a vesical urinary fistula. A very remarkable case was related by M. Hippolyte Larrey, before the Académie de Médecine, of a dermoid cyst of the ovary complicated by a urinary fistula in the median line of the abdomen, half way between the pubis and the umbilicus. It occurred in a previously quite healthy woman, aged 33, who had borne three children, and had had rapid recoveries after her confinements. Some days after the third, however, she felt a severe pain with heat and swelling in the left iliac region, and pus was passed with the urine. For five years all symptoms subsided; then the tumor increased, and

¹ Medical and Surgical History of the War of the Rebellion, Part II. Surgical Vol., p. 264.

² Trans. Path. Soc. Lond., vol. ii. p. 228.

³ Philos. Trans., vol. xl. p. 375. 1737-1738.

spontaneously opened below the umbilicus, and a quantity of hair and pus was discharged. Afterwards, urine in large quantities passed by this abdominal opening. Some of the hair from the cyst likewise escaped into the bladder, through a fistulous communication, and there, phosphatic matter being deposited upon the hair, so considerable a calculus was formed as to entirely prevent any urine flowing off by the urethra, so that at length the whole of it was passed through the fistula. The patient was cured by a single operation, which consisted in introducing a bistoury at the abdominal fistula, and laying open the cyst by cutting the abdominal parietes downwards along the median line; then with a sound in the bladder and the finger in the lower part of the cyst, the fistulous communication between the cyst and the bladder was found, and enlarged, and the calculus was removed through the incisions thus made.

(f) Inflammation of the peritoneum, or of some one of the pelvic viscera, may lead to adhesion and ulceration of the bladder, and then to a circumscribed abscess, which, bursting through the abdominal wall, results in an urinary fistula indirectly communicating with the bladder.

(g) Similarly, inflammation of the sub-peritoneal cellular tissue may lead to suppuration around and ulceration into the bladder; and by the burrowing of pus an external opening may be formed on the abdomen, above the pubes, at the groins, by the side of the anus or in the adjacent parts of the nates, or over one of the large foramina of the pelvis, a complete urinary fistula being thereby established.

(2) *Vesico-visceral Fistulæ*.—Urinary fistulæ are not unfrequently established between the bladder and rectum, bladder and vagina, or bladder and small intestine, as the result of inflammatory adhesions and ulceration between those parts. When the small intestine becomes matted together, and adherent to a sloughing or ulcerating bladder, a firm tumor may be formed in the hypogastrium, and be mistaken for a distended bladder. I have elsewhere reported a case somewhat in point.¹

Simple chronic inflammation, tubercle, cancer of the bowel, uterus, or vagina, and cystic and other diseases of the ovary, are common causes of these forms of urinary fistula. Stricture of the urethra, calculus, or indeed any cause within the bladder which excites adhesion to parts around and ulceration of the bladder-walls, will conduce to them.

URETHRAL FISTULÆ OPENING EXTERNALLY THROUGH THE WALLS OF THE ABDOMEN.—In extravasation of urine from stricture of, or injury to, the urethra, and also occasionally after lithotomy, the urine may find its way behind the triangular ligament into the pelvic cellular tissue, when, unless death quickly takes place, suppuration is excited, and matter may point above Poupart's ligament on one side or the other. Thus an urinary fistula is formed. I have seen this happen after lateral lithotomy; the pus burrowed up through the pelvis, and along the spermatic cord, and was let out below the external abdominal ring. The patient, a man aged fifty-six, died fourteen days after the lithotomy from a large abscess in the liver.

When the urine, after extravasation in front of the triangular ligament, finds its way beneath the skin of the abdomen, it may travel as high as the umbilicus, and a fistula may form in the groin, or elsewhere upon the front or side of the abdomen.

In these cases as in those of deeper-seated extravasation, suppuration is generally very free, but the fistulous opening will soon emit urine if the patient lives through the period of suppuration. Wilmot² relates a case of

¹ Medical Times and Gazette, July 28, 1883, p. 92.

² Stricture of the Urethra, p. 179.

extravasation of urine from a ruptured urethra complicated with fracture of the left ramus of the pubis. Perineal fistulæ formed, and others opened in the thighs, right groin, and above the pubes. All of them discharged urine, nearly the whole of which fluid escaped by the fistulæ for more than a year, and until Mr. Cusack, under whose care the patient was, re-established the normal urethra by dividing a fold of false membrane which had been obstructing the canal opposite to the seat of fracture. Sir Benjamin Brodie found, after death, "a large abscess in front of the pubis, extending half way towards the navel; another among the adductor muscles of the left thigh; and a third among the muscles of the upper part of the right thigh, as far outwards as the foramen ovale of the ischium, the periosteum having been destroyed and the bone itself rendered carious; and all these abscesses could be traced into an abscess in the perineum, communicating with the urethra, behind a stricture, by a small orifice." In an interesting inaugural dissertation on Urinary Fistulæ, by J. Antonius Jagielski, a case is related of a farm laborer, who, in June, 1819, was gored by a bull, the horn of which passed through the middle of the right thigh, towards the perineum and scrotum, blood trickling from the urethra; a stricture of the urethra followed, and immense urinary fistulæ resulted, and opened in the upper part of the thigh on its inner and posterior aspects, in the scrotum, and in the ischial regions; urine had also burrowed amid the cellular tissue of the pelvis and led to a large stinking abscess, as well as to contraction of the tissue around the rectum, and such great destruction of it as to expose the three inferior sacral nerves.

Matter pent up behind the deep perineal fascia is likely to burrow in the pelvic cellular tissue, and, dissecting its way by the side of the bladder, to open into the vagina, rectum, or some other part of the bowel; and thus to establish a complete uretero-rectal, or uretero-vaginal, or vesico-rectal, or vesico-vaginal fistula.

Treatment.—No general rules can be laid down, for enough has been said to show that the cause of the fistula must be ascertained, and the treatment directed accordingly. One thing will always be requisite, viz., to establish a free, and, if possible, natural channel for the proper escape of urine. Thus if stricture exists, it must be treated; if a foreign body is in the bladder, it must be taken away. All causes of inflammation around the bladder must be removed, and if extravasation have occurred, the prompt surgical treatment demanded for that emergency, and for the cause which has given rise to it, must be at once brought into effect.

In most cases the condition is very pitiable, and a cure is consequently demanded. Every act of micturition is attended with the escape of urine through the fistulous channel. When this channel is wide and direct, precaution can be taken to keep the clothes dry and clean; but when it is oblique or tortuous, the urine dribbles away long after the act of micturition is over, there is an ammoniacal odor always present, the clothes cannot be kept dry nor the skin free from excoriation, and the state of the patient is one of loathing and disgust. If, under these circumstances, relief is not obtained, the health of the patient fails gradually, and death ensues.

URACHAL ABSCESS AND FISTULA.

Most writers on the development of the bladder have referred to the occasional patency of the urachus at the time of and after birth, and to the discharge of urine from its umbilical extremity, which, under that condition, is likely to take place. Very frequently, perhaps generally, the urachus at

birth is tubular for a short distance above the bladder,¹ but in after life it becomes a mere fibro-muscular cord. The urachus retains the tubular character of the allantois till about the thirtieth week of foetal life, but the exact time at which the metamorphosis of the allantois is complete, varies in different animals, and in different instances in the human subject. At birth, according to some observers, the urachus very frequently does not extend as far as the navel, but about five or six centimetres from the bladder passes into a number of tendinous threads, which unite with the right and left lateral ligaments of that organ. Luschka,² who holds this view, says, however, that in very many cases a tubular elongation of the mucous membrane of the bladder may be found, the commencement of which is indicated by a minute opening passing from the cavity of the bladder; but that generally, in place of this opening, a depression is to be seen, though even this is often absent, and all trace of tubular communication lost. Rokitansky³ says, "The urachus may remain patent to a certain distance from the bladder, or throughout its entire extent." Cruveilhier,⁴ following Boyer, states that in urachal fistula the urethra is always obliterated; and Boyer goes on to remark that the fistula ceases to exist as soon as the obstruction at the neck of the bladder is removed, so that the urine can flow by the urethra.⁵ That these distinguished anatomists were wrong in this opinion, there can be no doubt, if the case of Mr. Thomas Paget, of Leicester (which will be again referred to), and one reported in the *Medicinische Zeitung*,⁶ of Berlin, as well as a few others on record, are admitted to be urachal fistulae. Boyer⁷ is further of opinion that in the great number of cases in which there is a discharge of urine from the umbilicus of young persons and adults, the fistulae have not been caused by the dilatation of an unobliterated urachus; but that the real cause has been, *first*, an obstruction to the passage of urine by the urethra, and, *secondly*, to a herniary protrusion of the mucous membrane of the bladder through the rest of its coats, near the point of connection of the urachal ligament; and that this herniary protrusion has extended as far as the umbilicus, and has subsequently ruptured. He, however, records no case in support of his hypothesis, but the perusal of Mr. Paget's case makes me incline to think that there may be instances of the kind which Boyer supposes. In Mr. Paget's⁸ patient, the umbilical orifice of the fistula measured three inches by two inches; through it a hernial protrusion, the size of a goose's egg, had occurred, and along this the surgeon's fingers could be passed right into the bladder. Though the man had no difficulty in voiding urine, and though a catheter could easily be passed when he was under Mr. Paget's care, it is quite possible that some obstruction had existed in early life before the fistula had formed. I have made a dissection in one case, and reported another,⁹ in which saccular dilatation of the kidneys, ureters, and bladder occurred in a foetus, and in which the only cause of obstruction found on examination was a thin membranous septum, easily broken down with a small catheter, in

¹ See a thesis by Johannes Noreen, entitled "De mutatione luminum in vasis hominis nascentis in specie de uracho," in the fifth volume of Haller's *Disputationes Anatomicæ Selectæ*, pp. 713 *et seq.*

² Luschka, Brit. and For. Med.-Chir. Review, 1862.

³ Manual of Pathological Anatomy, Syd. Soc. Transl., vol. ii. p. 219.

⁴ Library of Medicine, ed. by Tweedie, vol. vii. p. 592.

⁵ *Traité d'anatomie*. Splanchnologie, p. 477.

⁶ *Med. Zeitung*, No. 19. 1837.

⁷ *Op. cit.*, p. 479.

⁸ *Med.-Chir. Trans.*, vol. xxxiii. p. 293. Mr. Paget's case is entitled "A case in which the urachus remained open, and a ring-shaped calculus, formed upon a hair in the bladder, was extracted through the umbilicus."

⁹ Congenital Hydronephrosis, with remarks on the Secretion and Excretion of Urine in the Foetus. *Proceedings of the Royal Medico-Chirurgical Society of London*, 1876; and *Lancet and Brit. Med. Journal*, May 13, 1876.

the membranous part of the urethra. A less complete septum might, perhaps, give rise to the umbilico-vesical hernia described by Boyer, and from the ease with which it yields to an instrument passed along the urethra, such a septum might not be suspected to have existed.

Agnew¹ has briefly mentioned a case seen by him, which, in the absence of proof to the contrary, is capable of being explained on Boyer's theory; it was that of a child, who had no fistulous opening at the umbilicus; but when urine was allowed to accumulate in the bladder, the navel became distended.

The kind of orifice is not the same in all urachal fistulae:—

1. In some, a peculiar, button-like, papillary or columnar projection at the umbilicus, having an orifice at its summit, has been described. Mr. Bryant² mentions a case in which the projecting mass was about the size of, and not unlike, the glans penis. The orifice was constantly moist, but especially so when the bladder was distended. The boy was eight years old, and the condition was congenital. It was regarded as a case of open urachus. Mr. T. Smith³ gives a brief note of a case very similar to Mr. Bryant's. The boy was two years old, and had a button-like protrusion at the umbilicus, which was constantly moist, and the discharge, though slight, had the odor of urine.

2. The urine may escape at several points on the surface of a hernial protrusion, as in the case described in the *Medicinische Zeitung*. An infant aged four weeks had a urachal fistula discharging urine copiously through several points on the excoriated surface of a hernial swelling which projected three-quarters of an inch. The excoriated area was one-quarter of an inch long and one line broad. The urine was normally discharged by the urethra.

3. The orifice may be a mere deficiency—circular, oval, or irregular—in the linea alba. In the adult male patient under the care of Mr. Paget, of Leicester, it was circular, with a thick margin of cartilaginous hardness.

4. It may be situated in the cup-like depression of the navel, or hidden from view by the falling together of the skin of the umbilicus. In a second case described by Mr. Paget,⁴ that of a female child aged four months, the orifice was thus hidden from view, but on drawing aside the folds of skin, urine always escaped; the lining membrane of the tube was cuticular for a short distance, and then became mucous membrane; the orifice was large enough to receive an ordinary cedar pencil.

5. There may be, as already mentioned, a hernial protrusion at the umbilicus; the external covering of such a hernia instead of being skin is mucous membrane, which, however, becomes pale and dry after prolonged exposure. In these cases the fistulous orifice is at the side or on the summit of the hernia. In some cases the hernial protrusion acts like a plug to prevent the continual escape of urine, but is withdrawn during the act of micturition by the pull of the vesical muscular fibres, and thereupon urine is ejected at the fistula as well as along the urethra. This was the condition in Mr. Paget's adult patient; the first contraction of the bladder had no other effect than to draw into the abdomen the whole of the protruding parts, and until this was accomplished no urine passed by the urethra. The jet of urine from the umbilicus which then followed, was sudden, and ceased, not to be renewed except by a violent accelerating action of the expulsor muscles. The bladder would retain a pint of urine without any escaping, and it seems to me that this case sheds some light on several points connected with vesical rupture.

6. The fistula may be indirect. It will probably be so when an abscess

¹ Agnew's Surgery, vol. i. p. 388.

² Med. Times and Gazette, vol. i. p. 456. 1862.

³ Ibid., vol. i. p. 320. 1863.

⁴ Med.-Chir. Trans., vol. xlv. p. 13.

precedes it, as in the case reported by Mr. Savory.¹ This patient was a male child, aged thirteen months, in whom an abscess, which had been forming for eight weeks, pointed, and was opened at the umbilicus. The symptoms were pain in the lower part of the abdomen, and frequent desire to micturate. Vesical calculus was suspected. Afterwards there was a discharge of pus, and of nearly all the urine, through the umbilical fistula. The child died nine days after the abscess was opened. At the autopsy it was discovered that a polypus of the bladder had led to obstruction at the orifice of the urethra, and this to dilatation and suppuration of the ureters and kidneys. A small papilla on the upper part of the vesical wall represented the unobliterated urachus, but a probe could not be passed from the urachus into the bladder. Mr. Savory surmised that a valvular communication with the bladder had existed, and that the urine, having been propelled into the urachus, had set up suppuration around, so that by degrees the urachus had been destroyed, and an abscess cavity formed between the peritoneum and the rest of the abdominal parietes. The abscess extended in the course of the urachus from the bladder to the umbilicus. Though no opening could be detected after death between the bladder and abscess, or urachus and abscess, there is the fact that during life, for some days, nearly all the urine passed through the umbilical fistula, and the fair inference is that the urachus communicated with the abscess cavity.

Urachal fistulae may be either congenital or non-congenital. When an abscess precedes the fistula, as in the case just referred to, the latter is non-congenital; and in some cases where there has not been an abscess, the fistula is not congenital, though in all, the defect which makes it a possibility and which indeed predisposes to it—namely the non-obliteration of the urachal tube—is of course congenital. Dr. Francis Cadell² has reported the case of a girl aged eight, who from earliest infancy had had difficulty in micturition with frequent desire to pass water. From four years of age the symptoms of cystitis had increased, and when eight years old, after a few days of great pain, with swelling and hardness of the belly, urine was observed to come in a small stream from the navel. A No. 6 catheter could be passed through the fistula into the bladder. The child died four months afterwards from cystitis, with sacculated and suppurating ureters and kidneys. At the autopsy the umbilicus was found to be natural, save for the fistulous opening, which presented neither fungating granulations nor induration about its margins. The bladder was contracted and thickened, and the little finger could be passed from it into the unobliterated urachus, which gradually narrowed towards the navel. In this case the urachus must have been in part patent from birth, and have become gradually dilated until it gave way altogether, when a urinary fistula was established.

Mode of Origin of Non-congenital Fistula.—When the lower end of the urachus remains open, some of the urine is forced into it in each act of micturition, especially straining micturition, and at the commencement of the act, as was shown by Paget's case. If the bladder becomes after a time the seat of inflammation, the difficulty and straining in micturition will increase the dilatation of the urachus, as it does that of the ureters and pelves of the kidneys. Again, if, as Luschka seems to indicate, the vesical orifice of the urachus becomes very minute, or even closes, we see how the tube of the urachus may be converted into a shut sac; and then, if any urine or mucus is inclosed within it, inflammation and abscess will be caused, and the abscess may either burst spontaneously, or be opened by the surgeon, at the umbilicus,

¹ Med. Times and Gazette, vol. ii p. 106. 1852.

² Umbilical Urinary Fistula. Edin. Med. Journal, September, 1878, p. 221.

where it points. In either of these ways a non-congenital fistula may be formed, quite independently, as it would seem, of any mechanical obstruction at the neck of the bladder or in the urethra.

In Dr. Cadell's case, the fistula was direct, complete, and unassociated with abscess; but non-congenital, and urinary. When an abscess occurs after the obliteration of the vesical end of the urachus, and opens at the umbilicus, the resulting fistula is non-congenital, and may or may not be complete or urinary, according as there is or is not a communication between the abscess and the bladder.

Complications of Urachal Fistula.—Some of the complications are also in part causes, others are results, and others again merely coincident. Of the first set, there are polypus of the bladder, urethral calculus, phimosis, congenital stricture, and everything which prevents the free discharge of urine by the natural passage. That these, though efficient, are only in part causes, is clear; as there must be also an imperfect closure of the urachus to permit of a true urachal fistula. When this patency does not exist, the bladder, ureters, and kidneys may all become sacculated, but without any tendency being shown to dilatation or re-opening of the urachus. This is proved by cases of congenital hydro-nephrosis. A remarkable complication or result of fistula was witnessed in Paget's adult patient: a ring calculus (Fig. 1202) was formed by the deposit of uric acid on a small hair from the pubes, which had

Fig. 1202.



Ring calculus extracted through a urachal fistula. (T. Paget.)

found its way into the bladder through the umbilical opening. Cruveilhier¹ also met with a calculous concretion within the urachus, and he goes on to remark that Huller and Harder have made similar observations. Boyer² says that in 1787 he dissected the bladder of a man aged 26, whose urachus formed a canal an inch and a half long, and contained twelve urinary calculi as large as millet-seeds, one being larger and resembling a grain of barley. Though a fistula did not exist in this case, there was here a very sufficient exciting cause of abscess or ulceration, which might easily have resulted in a fistula.

Luschka³ has suggested that the cells of the lining mucous membrane of the urachus may occasionally be developed into cysts and need surgical interference; he does not, however, record any case of the sort.

Prognosis.—When the fistula is congenital, and caused by some obstruction to the outflow of the urine, the prognosis is unfavorable, as death from renal disease is likely to result, unless the source of the obstruction be removable, like phimosis or urethral calculus. When the fistula is non-congenital, and follows cystitis or abscess, the health of the patient will have been greatly destroyed, in all probability, before the fistula is established, and death will occur subsequently from exhaustion, cystitis, or pyelo-nephritis. In cases of simple patency of the urachus, without urinary obstruction, there is no reason why life should be interfered with, though the comfort of the individual necessarily is so.

Treatment.—There are two clear indications, namely: (1) to remove any source of obstruction to the natural discharge of urine, and (2) to close the fistula when there is nothing (like cystitis, or obstruction) to require it to be kept open. When phimosis exists circumcision should be performed, as in a case recorded by Dr. J. J. Charles,⁴ of Belfast. When a calculus is present it must of course be removed. If cystitis exists, dilatation of the urethra in the female, and

¹ Op. cit., p. 592.

² Op. cit., p. 477.

³ Virchow's Archiv, Band xxiii. Heft. 1 und 2, S. 1.

⁴ British Med. Journal, October 16, 1875.

median external urethrotomy in the male, will assist in relieving the cystitis, if it does not effect a cure of the fistula.

With a view of closing the umbilical orifice of the fistula, different methods have been tried, and each may succeed, though all may fail. If the opening is a vent for pus, or for urine which cannot, or can only with difficulty, pass through the urethra, no attempt at closure ought to be made. When the opening is upon a papillary outgrowth, it is sometimes sufficient to apply a ligature around the base of the papilla, which in a few days will then dry up and fall off, and the fistula will be permanently closed. In other cases nitric acid, or the actual or Paquelin's cautery, may be applied to freshen the edges of the orifice, with the view of starting healthy granulations. In other cases, again, the plan of dissecting off the skin around the opening and bringing the raw surfaces together with hare-lip pins, as was so successfully done by Mr. Paget in his two cases, should certainly be tried. In Mr. Paget's first case, the operation was performed when the patient was fifty-five years of age.

FECAL FISTULÆ.

Fecal fistula differs from so-called "artificial anus" in having much smaller external and internal orifices, and consequently in not allowing of the discharge of more than a small portion of the intestinal contents through them, instead of the whole, or nearly the whole, as is the case in the other affection. Moreover, a fecal fistula, though sometimes very short and direct, has generally, as its name implies, a narrow track or channel between its intestinal and outer orifices, and sometimes this track is long and sinuous; whereas, in artificial anus the internal orifice, which involves a great part, if not the whole of the lumen of the bowel, is adherent to the parietal peritoneum, so as to be nearly, or perhaps exactly, opposite the opening in the skin. Again, whereas an "artificial anus" always opens upon the cutaneous surface, some fecal fistulæ open internally into other viscera, for example, the vagina, urinary bladder, gall-bladder, stomach, or some other part of the bowel. Fecal fistulæ, too, are sometimes "blind:" that is, the fecal matter which escapes from the intestinal orifice burrows in the retro-peritoneal cellular tissue, or passes into an abscess-cavity, instead of being discharged through a second opening; these cases, however, are considered under the headings of fecal extravasation and fecal abscess, and need not be further referred to here.

There is a form of fistula, intermediate between the complete and the blind, in which the intestine communicates with an abscess, and the abscess with the surface; as in Dr. Coupland's case, for instance, mentioned under the heading of retro-peritoneal extravasation (p. 547), in which both the stomach and descending colon communicated with an abscess in the left hypochondriac and lumbar regions, from which pus and fecal matter escaped through an opening in the loin.

Fecal fistulæ may communicate with any part of either small or large bowel; sometimes there is more than one opening in the bowel, as there frequently is more than one on the surface. I have seen three or four perforated ulcers in the cæcum, opening into the same fistulous track; and I have had for the last eighteen months under my care, a child with a fecal fistula following the bursting of an abscess and communicating with the transverse colon, in whom there were, when first seen by me, two external openings in the linea alba, and in whom a third formed, shortly afterwards, on one side of the other two; all the fistulous tracks communicated in the substance of the abdominal wall beneath the reddened and undermined skin. Velpeau men-

tions a case in which there were five or six distinct external apertures, and Dupuytren refers to a somewhat similar instance. Gross,¹ in speaking of the external orifice of "artificial anus," says, that instead of a single opening there are occasionally several, which communicate with the main outlet and sometimes with each other, and he continues, "this perforated and cribriform state of the parts is generally produced by some of the stercoraceous matter insinuating itself amongst the muscular fibres and cellular substance of the abdomen, before the margins of the external orifice are sufficiently protected by the new adhesions. An abscess soon forms, preceded by an erysipelatous blush of the skin, and followed by a discharge of purulent matter, almost insupportably fetid in its character." This account exactly describes what occurred in a case of fecal fistula under my own care, in which the greater part of the fecal matter was passed by the anus.

Causes of Fecal Fistula.—Fecal fistulæ are either congenital, and due to defects of development; or non-congenital, and the effect of pathological causes.

Congenital fecal fistula is occasionally due to the persistence of the omphalo-mesenteric duct. This constitutes a rare form of umbilical fistula, attended with a fecal or biliary discharge. Cooper Forster² mentions two such cases, and Holmes³ alludes to two others, in one of which the fluid which escaped was pure bile, in the other a mixture of bile with the ordinary intestinal contents and ingesta. Prof. Marshall has reported the case⁴ of a male child, with a projecting tumor of the umbilicus, the size of a hazel-nut, of a florid-red color, and perforated at its apex by an orifice from which there was a constant mucous discharge. This opening led into a long canal, into which a probe passed backwards and to one side, and not downwards towards the bladder; nor had urine ever passed by the umbilicus. The direction of the canal, and the statement that fluid, in color and smell like the contents of the bowel, had occasionally exuded from the external orifice, led Mr. Marshall to diagnose the case as one of that rare condition—namely, persistence of the early connection between the umbilical vesicle and the intestine of the embryo; the red protrusion being the enlarged stump of the umbilical cord. The external orifice was successfully closed by dissecting away the mucous membrane and bringing the raw edges together; but, as Mr. Marshall pointed out, there would always be a risk that fecal matter might accumulate in this (then closed) duct, and set up inflammation and suppuration.

In cases of abscess in the anterior wall of the abdomen, followed by discharge of such substances as cherry-stones, or other foreign or fecal matter, there is often an intestinal diverticulum formed, according to Meckel, by a persistence of the vitelline duct.

Another group of congenital fistulæ is formed by those associated with *imperforate anus*. These may open externally in the raphe, near the scrotum or near the posterior commissure of the labia, or on some other part of the perineum; or in the loin, as in a case seen by Larrey, in which the opening was three inches from the spine. I have a note of a case in which the rectum of a newborn child opened in the linea alba, between the umbilicus and symphysis pubis; and other cases are on record in which the fistulous opening has been in the linea alba, or in some other part of the front wall of the abdomen. In other cases the fistula opens internally, into the vagina, or in the male into the bladder or urethra. When the rectum opens into the vagina, the amount of suffering and inconvenience is sometimes remarkably slight. I operated,

¹ Experimental and Critical Inquiry into the Nature and Treatment of Wounds of the Intestines, p. 177.

² Surgical Diseases of Children, London, 1860.

³ Principles and Practice of Surgery, 3d ed.

⁴ Med. Times and Gaz., Dec. 5, 1868, p. 640.

in 1871, upon a child five months old, with a fistulous opening into the vagina, about the size of a crow's quill, or less; there was a mere dimple in the situation of the natural anus. An incision was made through this dimpled area, and a curved probe was passed in at the vaginal orifice, and felt for with the finger in the wound; it was then cut upon, and the edges of the incision in the bowel were stitched to the margins of the skin-wound; the new orifice was kept dilated with a small bougie; the vaginal fistula soon closed; and twelve months afterwards the mother described her child's condition as "just like that of any other healthy child of the same age." The little girl was alive, and in all respects quite well, in September, 1883.

When the opening is into the bladder or male urethra, the suffering and inconvenience are generally great; the fecal matter gives rise to the symptoms and conditions of stone in the bladder, and life is jeopardized unless an artificial anus is made higher up in the bowel.

The small size of the orifices, the slow escape of the fecal matter, and the difficulty with which it often passes from the bowel through the opening, make these cases much more of the nature of fecal fistula than of the nature of "artificial anus."

Non-congenital or Pathological Fistulæ.—(1) *External injury* may lead to fecal fistula in either of the following ways: (a) Both the abdominal parietes and the intestine may be perforated, and if the gut remain *in situ* opposite the external wound, adhesion taking place between the wounded gut and parietes, a fistula may follow without any extravasation into the peritoneum. An artificial anus is sometimes formed in this manner, but whether the fecal opening will be a fistula or an anus, depends on the size of the wound; an artificial anus may in a short time be converted by the healing process into a mere fistulous opening. (b) *Enterorrhaphy* may be performed, that is, the gut may be stitched and returned to the abdomen; but complete union not following, a fistula may result. (c) If the wounded gut be stitched to the external wound after the manner of Scarpa, Palfyn, or John Bell, either a fistula or artificial anus may result. Here again it may be at first an "artificial anus" and subsequently a fistula, which in turn may permanently close. (d) A blow may cause contusion of the bowel without actual perforation, and yet a fecal fistula may result from the subsequent sloughing of the contused gut. (e) Contusion of the parietes may lead to abscess, and this to adhesion, and then to ulceration of the bowel, and thus to fistula. (f) Shot-wounds of the small intestine nearly always prove fatal, but recovery with fecal fistula has occurred in some few instances. Guthrie¹ gives a case of recovery after musket-ball wound; the ball entered the right iliac region and came out a little below the umbilicus on the opposite side; "a fecal bilious discharge, evidently from the small intestine, took place." John Thomson² mentions a case of shot-wound in which the place of entrance was three inches above the posterior spinous process of the left ilium, and that of exit at the right hypochondrium near its middle. For fifteen days a part of the food taken came out at the posterior orifice, through which two lumbrici were also discharged. No vomiting occurred throughout the case, and recovery ensued.

Besides these two cases, Otis³ was only able to collect six instances of recovery from shot-wound of the small intestine, in either ancient or modern warfare, with one other case besides, in which it was doubtful where the intestinal opening was situated, though Otis inclined to the belief that the fecal

¹ Wounds and Injuries of the Abdomen, p. 35.

² Report of Observations made in the British Military Hospitals in Belgium, etc., p. 105.

³ Medical and Surgical History of the War of the Rebellion, Part II. Surg. Vol., p. 74.

fistula followed sloughing of the cæcum. The fistula in each of these cases appears soon to have closed.

In civil life, recovery with temporary fistula has followed enterorrhaphy in a gunshot wound of the small intestine;¹ but Otis tells us that it has not done so in military surgical practice. Larrey, however, treated a soldier who was wounded at the siege of Cairo (1799), by stitching the completely divided ileum to the edges of the external wound, with good result. After two months, the ends of the divided bowel were connected together by adhesions, and were almost in contact. The artificial anus contracted to a fistula, which was dressed and covered with Desault's tampon, at intervals, for another two months, and the patient left the hospital perfectly cured.²

Wounds of the large intestine, whether incised, lacerated, or gunshot, are much more frequently followed by recovery with a temporary or permanent fecal fistula. Otis states that patients with shot-wounds of the transverse colon have rarely survived, but that many survivals have been seen after perforations of the cæcum and ascending colon, and still more after wounds of the sigmoid flexure and descending colon. He goes on to say "not a few of these fortunate cases were complicated by groovings or perforations of the wings of the innominate. Nearly all were attended with stercoral fistulæ, which commonly closed after a time without operative interference, re opening at intervals and then healing permanently."³ He gives one case of recovery after shot-wound of the transverse colon; the ball entered on the left side at the junction of the tenth rib with its costal cartilage, passed backwards and slightly downwards through the abdomen, and came out behind and a little to the left of the second lumbar vertebra; small pieces of paper and clothing which had been driven in before the ball, escaped by the stomach and by the anus for three weeks; and for a long period on attempting to evacuate the bowels, feces and urine, and seeds of fruit eaten, passed by both wounds; a small piece of bone, too, was removed from each. Out of 59 cases of shot-wound of the large intestine during the War of the Rebellion, the stercoral fistula persisted in 9, and closed in 50—within a month in 17, within a year in 28, and in 5 at periods extending from one year to four.⁴ Teale's⁵ tables show the same favorable results.

(2) Probably the most frequent cause of fecal fistula in civil life is sloughing after *strangulated hernia*. If a small hole forms from ulceration or sloughing in the strangulated bowel after its reduction, a fistula, or an abscess followed by a fistula, will result, provided that adhesions have sealed the general peritoneal cavity against the risk of fecal effusion. Artificial anus follows when sloughing of a large part of the strangulated bowel occurs.

(3) *Abscess* may arise from other causes than external injury, and result in fecal fistula. Teale⁶ has collected four typical cases, Jobert⁷ gives others, and still others are given under the heading of fecal abscess in this article.

(4) Mr. Bryant⁸ has reported a remarkable case of fecal fistula which formed spontaneously at the lower end of an *ovariotomy wound*, on the fourteenth day after an operation for a semi-solid tumor of the left ovary complicated with ascites. The pedicle was secured in two parts by a strong whipcord ligature, and dropped back into the abdomen. After the free discharge of feces for four days, the fistula closed for seven days, and then opened again

¹ Gissing's case, Brit. Medical Journal, 1858. (A boy aged 17, injured by the bursting of an iron cannon.)

² Mém. de Chir. Mil. et Camp., t. ii. p. 160.

³ Op. cit., Part. II. Surg. Vol., pp. 76, 77. ⁴ Otis, op. cit., p. 98.

⁵ Teale, Art. "Intestinal Fistula," in Costello's Cyclopædia of Practical Surgery, vol. ii.

⁶ Ibid., p. 361.

⁷ Maladies du Canal Intestinal, tome ii. 1829.

⁸ Guy's Hosp. Reports, 3d series, vol. xiv. p. 228.

and discharged, besides feces, the double loop of ligature with which the pedicle had been secured. In three days from this time the wound had healed, and in three weeks more the patient had left the hospital well.

(5) Any disease of the bowel which causes *ulceration or sloughing* may lead to fecal fistula. Thus simple, syphilitic, and cancerous strictures, and other causes of intestinal obstruction, frequently give rise to internal or external fecal fistula, fecal abscess, or fecal extravasation. Mr. Garlick,¹ of Marlborough, reported the case of a gentleman aged sixty-five, who suffered from cancerous stricture of the sigmoid flexure, and who for six weeks before his death passed no feces but what came away with his urine. At the post-mortem examination, a communication (more of the character of an artificial anus, however, than of a fistula) was found to exist between the colon and the fundus of the bladder; both colon and bladder at this part were much thickened, and the diameter of the colon, particularly the part of it which terminated in the rectum, was much contracted; this contraction was supposed to be the reason why no feces had been discharged *per anum*. I have performed colotomy upon an old gentleman with much the same condition, nearly all the feces being voided through the bladder and urethra. The relief afforded by colotomy in such cases is so great that it is simply cruel to deprive the patient of its benefit; nay more, it is bad practice to allow the disease ever to reach this stage without previously performing the operation. Entero-vaginal, recto-vaginal, gastro-colic, gastro-iliac, cæcal, and other fistule are formed in this way. Scarcely a fortnight passes without one or other of these forms of fistula, the result of cancer, being seen at the Middlesex Hospital.

(6) Fecal fistula is often the sequel of an attempted radical cure of *artificial anus*.

Prognosis.—When a fecal fistula is due to a wound, it generally closes spontaneously; when due to hernia, the prospect of recovery is good. When the bowel is obstructed by the pressure of a growth, or by adhesions or stricture, the chance of cure must largely depend upon the possibility of removing the cause of obstruction; it is generally very improbable, often quite impossible, to close the fistula arising from obstruction.

Diagnosis.—There is no difficulty in diagnosing most of these cases, because the fecal character of the discharge at once declares it in an external fistula, and the passage of fecal matter by the vagina, urethra, stomach, or lungs, declares it in many of the internal. Blind fistulæ, and fistulæ opening into abscesses, may, however, be undetected for some time or altogether, and fistulous openings between different parts of the intestine may not be suspected.

Nor can the situation of the intestinal opening be always rightly inferred from the character of the matter which escapes. The negative evidence of an inodorous or non-feculent discharge is suggestive of some part of the jejunum, or quite upper part of the ileum, whilst the positive evidence of semi-solid feces points to the large intestine, and pure bile to the duodenum or upper part of the jejunum. But it must be remembered that fecal matter sometimes escapes from the stomach, owing to a communication with the colon, whilst in other cases fluid taken by the mouth may in a few minutes be discharged through a colic fistula; as in a case which I have elsewhere quoted, in which the transverse colon communicated with the duodenum as well as with the surface of the abdomen. I once performed right colotomy on one of my colleague Dr. Powell's patients, who was suffering from abdominal distension due to obstruction—as I thought, in the transverse or splenic flexure of the colon. The operation was successful in completely relieving the patient

¹ Lond. Medical Journal, p. 188. 1784.

from his sufferings, and in prolonging life for some days; but the post-mortem examination proved that my diagnosis was wrong. The obstruction was due to the adhesion together of some coils of small intestine, between one of which and the ascending colon just below the cæcum a free communication existed, so that after the operation the contents of the small intestine mixed with those of the cæcum and colon, and were drained away through the operation wound.

Treatment.—Cleanliness, the recumbent posture, and some flat, equable compression upon the parietes over and beyond the fistula, should be employed. I have tried paring the edges and bringing them in contact with hare-lip pins and sutures, and also the application of caustics, but without success; and yet, after failure with these methods, very great improvement has followed the enforcement of the supine position, with compression, and the proper selection of food. Sheet lead, or gutta-percha, or a large flat air-pad attached to the centre of an abdominal belt, when the fistula is in the front of the abdomen, will be found useful for exercising pressure. Mensel, of Gotha, has cured two cases of intractable intestinal fistula by abdominal incision, followed by suture of the fistulous opening of the intestine, after dissecting it away from the edges of the parietal opening. Catgut sutures were employed for the closure of the bowel, the bowel was dropped back into the abdominal cavity, and the external incision was closed in the usual way. Convalescence was complete in one case in ten days, and in the other in fourteen days.¹ The food should be light and easily digested, and should consist of soft animal and farinaceous solids; for liquids are much more apt to pass readily through the fistula, and vegetable substances are not readily absorbed. Constipation should be avoided. By keeping on his back, the patient aids the action of gravity to deter the intestinal contents from entering the fistula. The excoriation and eczematous inflammation produced by the acridity of the discharges are best prevented by using zinc or spermaceti ointment, on lint placed widely around the opening. Sulphate of iron lotion (100 grains to the pint of distilled water) is sometimes very beneficial, but when there is much smarting or irritation, warm lead lotion is the best application.

FALSE ANUS; COMMONLY CALLED ARTIFICIAL ANUS.

The term “artificial anus,” as nearly all writers on the subject have pointed out, is ill adapted for those varieties of the disease which are not the designed result of surgical operation. Nor are “abnormal anus,” suggested by Dupuytren, nor “anus contre nature,” used by Jobert, any better, for the reason that the genuine “artificial” anus of surgery is equally “abnormal” and “unnatural” with the rest. Many French writers have superseded the word “artificial,” as applied to cases not the result of operation, by the word “preternatural,” but as this implies a something which is strange and unheard of, it is not suitable; whilst the term “accidental,”² also employed by Jobert, is only suitable to cases which result from external violence. I have, therefore, proposed the word “false,” and shall here employ the expression “false anus” for all abnormal external communications with the bowel which have not been designedly established by the surgeon, and which are too large to be included under the term “fecal fistula.”³ “Aberrant” would be a name well adapted for such openings, for the word implies a deviation from the right

¹ Lond. Med. Record, May, 1883, p. 186.

² In his excellent work on Surgical Diseases of the Intestinal Canal, Jobert speaks of two forms of “anus contre nature:” 1. The *accidental*, which follows gangrened hernia and intestinal lesions, and 2. The *original*, which is due to some vice of development.

course through some error or fault, and in this sense is actually in use in natural history. But it is longer and less English than "false." "Artificial" anus is thus reserved for, and ought to be restricted to, a new and abnormal outlet formed by surgical art for the purpose of affording relief in cases of insurmountable obstruction in the bowel below, and of imperforate anus. In this sense there are three classical forms of artificial anus: 1. Lumbar; 2. Iliac; and 3. Perineal. Exception has also been taken to the word anus, in all these cases; and not without ground, for in none of them does the opening possess a sphincter.

A false anus differs from a fecal fistula in the greater size of the intestinal and external orifices, in their greater proximity to one another, and in the much greater quantity of intestinal contents which passes through them. The characteristics of a false anus are that: (1) the whole, or the greater part of

Fig. 1203.

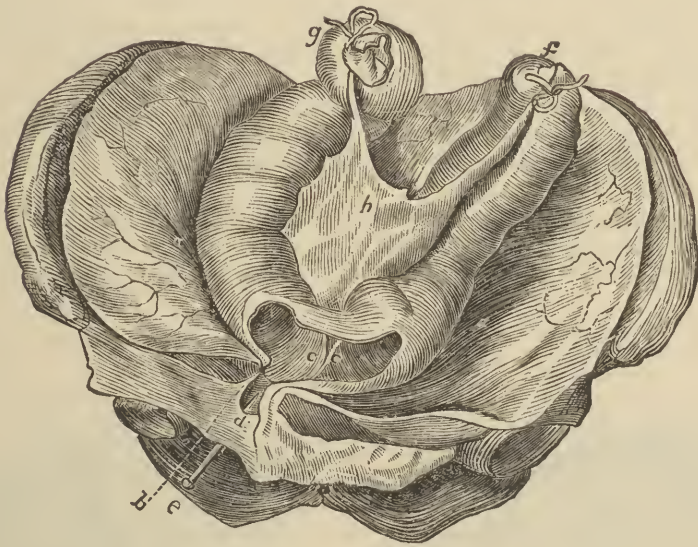


Diagram of the relations of a false anus resulting from sloughing of a knuckle of ileum. *a a*, peritoneum covering iliac fossæ; *h*, point where peritoneum forms part of infundibulum; *c*, *éperon*; *d e*, fistulous track and outlet of false anus; *f* upper part of gut; *g*, lower part of gut; *h*, mesentery. (After Scarpa and Otis.)

the fecal matter escapes; (2) the will of the individual has no influence in retarding the escape; (3) the swollen, and more or less protruding, mucous membrane of the ends of the intestine becomes still more protruding during the escape of the fecal matters; (4) the ends of the bowel are adherent to the surrounding parts by false membrane.

Situation.—A false anus may be situated in any part of the abdomen: as the result of external violence it is met with in the loins, hypochondria, umbilical, iliac, hypogastric, and sacral regions; but as the result of disease it most commonly affects the hernial regions—inguinal, scrotal, femoral, and umbilical—and more particularly the first two. Any point in the intestinal canal may be the seat of the internal opening, but it is most frequent in a part which, being free to reach the hernial apertures, can thus be strangulated in

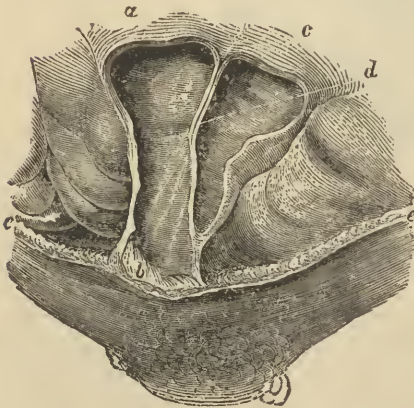
them; consequently the ileum is most frequently affected in this way, though the large intestine is very often involved as a result of traumatic lesion.

Causes.—First and chief amongst the causes of false anus is hernia, neglected and operated upon too late, or not operated upon at all; thus by gangrene or ulceration, or by either of these processes combined with fecal abscess, the larger proportion of the cases seen in civil practice are formed. Second, but much more rare in civil life, though by no means infrequent in warfare, come contused, incised, lacerated, and gunshot wounds. Third, foreign bodies arrested in the intestine lead to adhesions and perforations, followed by fecal abscess, and this in turn by either a fecal fistula or a false anus. Fourth, abscess, whether commencing in the parietes and involving the intestine secondarily, or commencing in ulceration of the intestinal mucous membrane, and subsequently implicating the parietes. Fifth, false anus may be congenital, the result of some error of development. It is then usually situated at the umbilicus, or lower down in the linea alba. The openings in some of these congenital cases are so small, the amount of intestinal contents which passes through them so insignificant, and the consequent distension so considerable and fatal, that fecal fistula, not false anus, is the proper name for them. Sixth, Jobert alludes to a fatal case of false anus, caused by a surgeon who mistook a fecal accumulation for an abscess, and plunged a bistoury into the swelling.

The whole or any part of the circumference of the bowel may be severed by the injury or disease which causes the false anus. Upon the extent of the lesion depend both the gravity of the case and the nature of the treatment to be adopted.

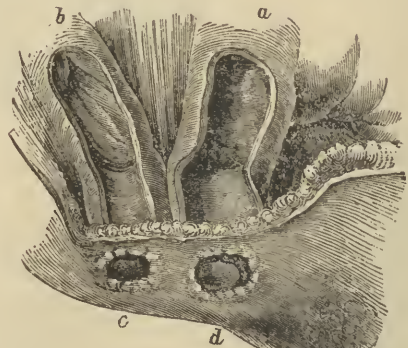
Pathological Anatomy.—The external orifice varies much in size and appearance. It is usually single (Fig. 1204), but may be double (Fig. 1205), and has been described as cribriform or sieve-like. Dupuytren observes:—

Fig. 1204.



Intestinal fistula from Dupuytren's collection. *a*, upper part of intestine; *b*, aperture of the same; *c*, lower portion of intestine; *d*, projecting valve closing entrance to lower portion of intestine. (After Teale.)

Fig. 1205.



Intestinal fistula from Dupuytren's collection. *a*, upper portion of intestine; *b*, lower portion; *c*, aperture of lower portion; *d*, aperture of upper portion. (After Teale.)

The opening, in whatever way occasioned, is almost always roundish, but sometimes of an irregular shape. Its diameters vary from a few lines to an inch or more. In the

majority of persons its edges are thick, depressed, adherent to the subjacent parts, inclined towards the abdominal cavity, and immediately continuous with the mucous membrane of the bowel. A reddish circle denotes the place of their junction. The neighboring integuments have radiating furrows in them, *en cul-de-poule*, analogous to what is observed near cicatrices in general; and notwithstanding the most minute attention to cleanliness, the matter evacuated irritates the skin, bringing on an erysipelatous redness, or excoriations of variable depth.

The distance between the outer opening and the lower edge of the intestinal aperture, varies with the cause of the affection and the thickness of the abdominal walls. It is usually from one-third to one inch, but it may be two, or even three inches. The two ends of the bowel are sealed by plastic lymph to the parietal peritoneum around the outer orifice, and thus the peritoneal cavity is safely shut off. The extent of these adhesions varies, but they are not often more than from one-twelfth to one-quarter of an inch wide. If they be feeble, the intestine may be pushed, torn, or dragged away, and completely separated from the parietes, and the patient will then die of fecal extravasation into the peritoneal cavity; but in old cases the adhesions are apt to yield gradually to the constant dragging action of the mesentery, without any ill effect resulting, and the gut becomes, perhaps, as Dupuytren proved it might, completely restored to its free and floating condition. When the false anus results from disease, the formation of this barrier of adhesions precedes the sloughing of the bowel; when due to injury, the barrier has to be thrown up around the wounded part, and until this has been completed, there is danger of effusion into the peritoneum. The adhesions never extend far along the extremities of the bowel, which, being merely contiguous, leave between them a *cul-de-sac*, into which, in some instances, the viscera press so as to give rise to a hernial protrusion, which pushes forwards and otherwise complicates the false anus.

The two ends of the spoiled bowel, which are thus attached to the deep margin of the external opening, vary in their relation to one another. Sometimes, if the lesion of the wall of the bowel is not extensive, they are very obliquely placed, and then there is a good prospect of the intestinal contents passing from the upper to the lower portion, and so reaching the anus, and favoring the spontaneous closure of the abnormal opening; sometimes they are quite parallel, or, in the stereotyped phrase, side by side like the tubes of a double-barrelled gun. As Dupuytren observes, the two terminating portions of the bowel pass into the abdomen, sometimes crossing, sometimes coiling over one another; in other instances running parallel, but most frequently diverging at a more or less acute angle. Lastly, they terminate in bending more and more to become lost in the convolutions of the intestinal canal. Each end of the gut opens by a distinct orifice, separated by a spur or septum more or less pronounced, to which Dupuytren gave the name of "*éperon*," and Scarpa that of "the promontory." This spur consists of the mesenteric side of the bowel, if it has been spared; and if not, of the contiguous and now united mesenteric sides of the two ends of the bowel. In the latter case, the *éperon* forms a complete barrier between the upper and lower orifices, and intestinal matter cannot pass from one to the other except by describing a kind of semicircular course outside them, and in the infundibulum of Scarpa, to be presently mentioned. The *éperon*, after a time, does not divide the orifices equally, but is propelled towards the lower part of the bowel by the pressure of the matter passing constantly through the upper orifice; thus the upper opening increases in size as time goes on, and the lower one contracts until by degrees it becomes so shut off that it is only detected with difficulty. The two ends of the bowel undergo other important changes in

time, besides those of size. The upper one, from its incessant activity, receives an extra supply of blood, and in consequence increases in volume and strength; and this excess of life is imparted to the mesentery, and to the glandular and muscular structures of the bowel. The lower portion, on the other hand, atrophies, though it is rarely, if ever, obliterated entirely;¹ but its muscular, mucous, glandular, and mesenteric apparatus all waste, and, to such a degree that, as Dupuytren has pointed out, after some years the difference between the upper and lower ends of the intestinal tube is so great that while the former seems to be that of an adult, the lower looks as if it belonged to a new-born infant. Jobert says of it, "qui est revenu sur lui-même, comme un intestin de chat, et qui ressemble parfaitement à un intestin grêle d'enfant."² Otis³ says that a feature common to all the cases of abnormal anus, the result of wounds during the war, was the absence, or but slight development, of the crescent-shaped septum, or *éperon*, commonly found in cases of false anus following gangrened hernia. That this septum is not a necessary or a frequent consequence of the destruction of a limited portion of the intestinal wall by injury, though at variance with Scarpa's teaching, is, Otis thinks, the most important practical lesson deduced from the many instances of spontaneous recovery from extensive wounds of the large intestines.

According to Scarpa, in a false anus resulting from gangrene of a hernia, the ends of the bowel are embraced by a sort of membranous funnel (*entonnoir membraneux*) or *infundibulum*, the other extremity of which is attached to the integuments. The interval which exists between the two ends of the *infundibulum* is sometimes obliterated, sometimes sinuous, and at other times straight. This *infundibulum* opens upon the surface, generally by a single, round, or more or less irregular aperture. It is organized exactly like a fistulous track, and is lined by a sort of mucous membrane, which is continuous with that of the intestine, but which has neither follicles nor villousities like the latter. Though thin, this false membrane yet serves to protect the surrounding parts from infiltration with fecal matters. If the hernial sac has not been destroyed by gangrene, or by ulceration and contact with the fecal matters, the *infundibulum* is formed by this sac, which becomes coated with plastic lymph. The funnel may be short, especially if the bowel descends very low, or actually reaches the skin; on the other hand, it may be very long, and then the fecal matter has to course through a long passage to reach the external opening. Dupuytren, Jobert, and others, confirm Scarpa's description of this *infundibulum*, which, however, does not exist in traumatic false anus, nor in all cases the result of gangrened rupture. When the funnel is not present, the gut is attached to the margin of the opening in the muscles and skin of the parietes. Repair seems to be more rapid, and spontaneous cure more probable and perfect, in cases in which the *infundibulum* is long and large, than in others; and Scarpa has pointed out that the breach in the intestine is never repaired by the orifices of the two ends of the gut reuniting, as they are at a very acute angle to one another, but that it is by means of the funnel-shaped cavity that the two parts of the bowel communicate, the fecal matter passing in a semicircular manner through the funnel from one side of the *éperon* to the other.

Symptoms.—These consist in the discharge, through the abnormal opening, of fecal matter, mucous substances which have not undergone absorption,

¹ The case of M. Bégin, quoted by nearly all writers, shows that this obliteration is not impossible. The patient died at eighty, having for forty years had a false anus in the left groin, communicating with the arch of the colon.

² ["Which is contracted, like the intestine of a cat, and which exactly resembles the small intestine of a child."]

³ Med. and Surg. History of War of Rebellion, Part II., Surg. Vol., p. 109.

and the different secretions which are poured into the intestine or produced by it; and the ill consequences which follow from this discharge. Colicky pains are often experienced, and are attributed by Jobert to the inability of a great part of the bowel to perform its usual functions. The inflammatory affections of the skin around the opening have been already alluded to; and in old, long-standing cases, callosities occur from the irritation and inflammation excited by the acidity of the constantly escaping matters. Differences in the character of the matters which escape, and in the length of the interval between taking food and the flow from the false anus, depend upon the exact situation of the intestinal opening: the nearer the stomach the less feculent and more chyle-like the discharge, and the shorter the interval before its escape. Although there are not a few cases in which the health and strength of patients thus afflicted have been preserved, in a greater number the ill effects upon the constitution are very marked; loss of strength, rapid emaciation, and death from inanition, are the result of the food remaining too short a time in the digestive tube. Another effect of the same cause is witnessed in the very voracious appetite which these patients sometimes have.

Terminations.—Desault, Leblanc, Hoin, and Jobert have observed patients thus affected die from inanition. Jobert speaks of death from rupture of the intestine due to crossing of the ends of the bowel; Dupuytren, of two cases seen by him of death from rupture of bowel and escape of fecal matter into the peritoneum. Strangulation of the ends of the intestine is sometimes the cause of death, and is caused either by over-lapping or crossing of the ends of the bowel, or by prolapse. Puy, of Lyons, saw two cases of death from this cause, and Hoin, Leblanc, and Sabatier cite similar instances.

Though it is true that in the greater number of cases which have resulted from the total destruction of a convolution of the bowel, the false anus persists through life, and patients have lived 15, 20, and even 40 years with it; it is also true that in some cases in which the surgeon's skill has proved powerless, nature has effected a cure most unexpectedly. Pipelet¹ gives a case, the result of a crural hernia, in which the cure was effected by false membrane, and the ends of the intestine thus closed in were withdrawn into the belly. Wedemeyer, of Hanover, relates a case of a woman, aged 32, with a false anus from a gangrened rupture which had resisted all attempts at cure. She became pregnant, and as pregnancy advanced the fecal discharge diminished; towards the close of gestation nothing escaped except a little pus and serum; and in two months after her confinement the opening had securely healed. It was very different in a case in which I had operated for crural hernia, and was subsequently consulted on account of intestinal obstruction during pregnancy:—² A false anus followed the operation within a few hours, from sloughing of the part of the bowel which had been strangulated, but a spontaneous cure occurred within six weeks. Some two years afterwards the woman became pregnant, and between the fourth and fifth months of pregnancy, intestinal obstruction attended by severe symptoms occurred, owing as we supposed to interference with the adherent coil of bowel by the enlarging uterus. Abortion was consequently induced by sponge tents, and complete recovery ensued. Some years afterwards I heard through the family in whose service she had lived (her family medical attendant having died, and she having changed her place of residence), that this patient had died of bowel-obstruction during pregnancy; and from my experience of her previous attack, I do not doubt that the cause of death was the pressure exerted by the uterus upon the bowel which had been the seat of the false anus, and which still remained adherent in the femoral region and was bent at too acute an angle to allow

¹ Mém. de l'Acad. de Chir.

² Lancet, Feb. 4, 1871, p. 150, Case III.

of the passage of the intestinal contents. In the case in Sir A. Cooper's practice related by Mr. Hey, precisely the same sort of false anus as in my case, namely, following sloughing of a femoral hernia, was spontaneously cured, and the woman went through the efforts of parturition afterwards without ill effects.

Finally, other evils besides that which my case illustrates may happen after the complete cure of a false anus. Sabatier relates instances of death from rupture of the intestine, due to swallowing indigestible substances which could not pass through the part at which the false anus had been situated. Scarpa records a case which ended in death, as follows:—A young man who was almost cured of his false anus ate gluttonously of crab, demolishing not only its claws but their crustaceous covering; death ensued, and at the post-mortem examination the upper part of the bowel was found enormously dilated, and the lower part contracted; fecal matter had escaped into the peritoneal cavity, and there was a perforation at the upper part of the ileum through which portions of the crab were being discharged.

Complications.—(1) *Prolapse of the superior orifice* is the most frequent. It sometimes attains a great magnitude, being a foot or even more in length. It varies at different times, as in a case recorded by Sir W. Lawrence, of a man aged 60, who had voided his feces entirely through the groin for seventeen years. The projecting part was sometimes 4 inches, sometimes 8 or 10 inches long; it was equal in size to the forearm, and bled copiously. As a rule, the diameter does not exceed two and a half inches or thereabouts; its shape is conical or nearly cylindrical, being contracted at its base; and the mucous coat is swollen and congested.

(2) *Prolapse of the inferior orifice* is less common and less extensive than prolapse of the upper. It seems to be caused by peristaltic movements propelling the mucous excretion of the lower part of the intestine towards the false anus. Sabatier¹ has related two cases of prolapse of the lower orifice. One was that of a soldier, with an abnormal opening allowing of only partial escape of feces through it. After a colicky seizure, he found a nipple-like protrusion which soon reached the size of a fist, and ultimately, though it varied from time to time, was generally six inches long and one and a half inches in diameter. The man enjoyed good health, and was hearty and strong.

(3) *Prolapse of both orifices* has been represented by Sir A. Cooper in the second plate of the first part of his work on Hernia (second edition). Boursy² has also illustrated this condition, and two cases are quoted by Sir Wm. Lawrence³ from Albinus and Sabatier.

(4) False anus may be complicated with *hernia* in the manner which has already been alluded to.

Treatment.—The two chief indications are to remove the obstruction caused by the *éperon*, and to close the external opening. The treatment may be considered under the heads of Palliative and Curative Means.

I. *Palliative Treatment.*—(a) Pressure by a truss so applied as to allow of the periodical evacuation of the bowel. (b) The adaptation of a receptacle of which numerous patterns in numerous materials have been tried. (c) Colomb's plan of making the upper end communicate with the lower by means of a curved gum-elastic tube, two or three inches long.

II. *Curative Means.*—(1) To remedy any existing complication by (a) careful attention to diet, as mentioned in the treatment of fecal fistula; (b) an occasional evacuation per anum, by the use of enemata; (c) prevention or relief of prolapse by position and pressure; and (d) prevention of premature

¹ Mém. de l'Acad. de Chir., tome v. p. 398.

² See Teale's article in Costello's Cyclopaedia of Practical Surgery, vol. ii. p. 202.

³ Treatise on Ruptures, p. 419.

elclosure of the external opening, which would lead to partial or complete intestinal obstruction.

(2) To *diminish or remove the obstruction* caused by the *éperon*.

(a) *Compression of the éperon* by Desault's plan, which, consisted in the introduction into the two ends of the bowel of long tents, so as to dilate the lower part of the bowel and efface the angular projection between it and the upper. Desault placed also a plug of lint in the external aperture, to prevent the escape of fecal matter, and administered laxatives and clysters. He perfectly cured a sailor by this means. Larrey successfully adopted this plan, as did Scarpa with partial success. The Dublin method consisted in using a "propeller," which was introduced into the ends of the bowel, and which, whilst it retained the anterior wall of the bowel against the abdominal parietes, pressed back the *éperon* away from them.¹

(b) *Perforation of the Éperon*.—Schmalkalden, in an inaugural dissertation published at Wittenberg, in 1798, recommended the passage of a ligature through the base of the *éperon*, upon which traction was to be made so as gradually to cut through the tissues. Dr. Physick,² of Philadelphia, employed a similar process. Dupuytren,³ in May, 1813, passed a seton through the base of a very prominent *éperon*, in a case in which the two ends of the bowel were lying parallel to each other. He gradually increased the size of the seton until at length the whole depth of the *éperon* was cut through. A free communication was thus established between the two ends of the bowel; but as complete cure did not forthwith result, he cut away portions of the *éperon* with scissors, set up peritonitis, and the man died. He afterwards abandoned this mode of treatment. Such a proceeding is only applicable where perfect adhesion has occurred between the two serous layers of the coats forming the *éperon*: where this has not occurred, the transit of the needle and thread would cause a double perforation of the peritoneal cavity.

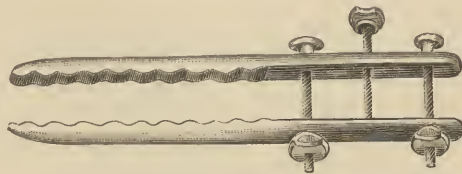
(c) *Destruction of the Éperon by means of the Enterotome*.—This is the method of Dupuytren; the enterotome devised by him (Fig. 1206) consists of three pieces, viz., two branches, which lock like the blades of a midwifery forceps, and a

Fig. 1206.



Dupuytren's enterotome.

Fig. 1207.



Blasius's enterotome.

screw, whereby the handles can be approximated or separated. The male blade is received, to the depth of a line, into a groove in the female blade. One blade is introduced into one part of the bowel, and the other blade into the other end of the bowel, to a depth varying from one to four inches. The blades are then locked, and approximated and held together by the screw-piece of the enterotome. The effects of this instrument are to augment the length of the parallelism of the two ends of the intestine and of their intermediate septum, and to bring about adhesion of the sides of the two pieces of bowel, and then complete division of the parts compressed by the teeth of the blades. The instrument falls off about the eighth day, and with it the included portion of the intestinal tissue, in a dry, parchment-like state.

¹ See Dublin Med. Press, vol. xiii. p. 305.

² See Dorsey, Elements of Surgery, 1813.

³ Mémoire sur les anus contre nature, p. 286.

Dupuytren gives the results in 41 operations performed by himself, Lallemand, and others: 3 patients died, 1 from fecal effusion, 1 from indigestion, 1 from peritonitis; 9 had fistula remaining; 29 were completely and permanently cured, in periods varying from two to six months. Colic, nausea, and vomiting occurred in some of the 38 cases of recovery, but the majority of the patients did not suffer any severe symptoms. In three-fourths of the cases thus operated upon, the false anus was caused by gangrenous hernia; in the other one-fourth by wounds of the abdomen, with loss of substance of the bowel. Heimann,¹ of Dornhan, gives statistics of 84 cases of "artificial," that is, false anus, treated by Dupuytren's method. In 76 of the 84 cases the result was more or less favorable: in 50 the opening completely healed up; in 26 a small fistula was left, which could be well closed with a compress, and the patients could resume even arduous occupations. In one of the 8 fatal cases, resection of the bowel had been subsequently performed. If this case is excluded, we have 83 cases with only seven deaths, a mortality of about 8.5 per cent., which compares most favorably with the 37 to 50 per cent. mortality of *resection of the bowel* mentioned further on, and shows Dupuytren's method to be a very successful operation, and one which ought to be preferred to a decidedly much more dangerous, if much more rapid procedure. Blasius, Liotard, Delpech, Reybard, Gross, and others have modified Dupuytren's

Fig. 1208.



Reybard's enterotome.

Fig. 1209.



Gross's enterotome.

enterotome, and Jobert, who recorded several unfavorable results with Dupuytren's instrument, proposed to apply it only with the view of obtaining adhesion, and not division of the septum. It has been pointed out by several writers on the subject, that adhesive inflammation does not always take place at the periphery of the enterotome, even after it has been applied in the most judicious manner; and further, that in some cases it is almost impossible not to include between the branches of the instrument some free loop of sound intestine. And yet, from Dr. Heimann's statistics, it appears that in only two cases (Dupuytren's and Gherinis's) did perforation occur, and in only one did death result from peritonitis extending from the portion of peritoneum included in the clamp. Heimann, as others before him have done, points out the danger of employing the enterotome too soon after the establishment of the false anus, and the advisability of screwing it up gradually, so that only a small portion of the spur may be compressed each time. The existence of a spur should of course be ascertained before having recourse to this mode of treatment.

The persistence of fecal fistula in a certain proportion of cases operated upon, was recognized and regretted by Dupuytren, who urged his juniors to set to work and find a means of promptly, and without danger, causing an opening in the skin, when useless, to cicatrize, in all cases. Mr. A. E. Barker, of University College Hospital, London, has adopted a plan described and figured by himself in the *Lancet*.² After dividing the *éperon* with

¹ Lond. Med. Record, May, 1883, p. 187.

² Lancet, Dec. 18, 1880, p. 971.

Wells's artery forceps, he introduced an India-rubber valve into the bowel in such a manner as to close the intestinal aperture, and fastened each end of the valve by means of a wire suture passed through the parietes of the abdomen. The valve was thin and flexible, and the pressure of the feces against its under surface was relied on to make it fit still more closely to the curves of the opening. His patient made a complete recovery, but it is uncertain to what extent, if any, the valve contributed to the cure.

(3) Another method of cure is to *obliterate and close the external opening*. This has been attempted in several ways: (a) Pressure by means of an elastic truss, or linen compress, which ought to extend considerably beyond the limits of the external opening. (b) The use of caustic, the actual cautery, or the thermocautery—a plan particularly recommended by Dieffenbach, who cured a case by thus destroying the edge of the bowel at its junction with the skin, and a considerable portion of the mucous membrane within the orifice, but without acting on the skin itself. (c) Suture, after freshening the edges of the opening. (d) Autoplasty, which consists in covering in the opening by a piece of skin detached from the neighborhood, and united by threads to the external aperture. Jobert, after failing with each of the above-named measures for closing the external opening, succeeded by the following manner: A portion of skin was dissected away at each side of, but at some little distance from, the artificial anus, and the raw surfaces were brought into contact in front of the opening, and secured by six twisted sutures. Thus was formed a kind of bridge over, with an open angle above and below, the false anus. After the escape of a little fecal matter from both lower and upper angles, the parts united in front of the opening, and a cure was perfected after some months.

(4) *Resection and circular suture of the intestine* has recently been somewhat largely practised both for gangrenous hernia and for false anus. From a critical review of this subject by MM. Bouilly and G. Assaky,¹ we learn that in the ten years following 1873 there were thirty-six cases of resection for gangrenous rupture, viz.: 21 femoral, 11 inguinal, 1 umbilical, and 3 unstated. The mortality was 50 per cent.; there were 16 complete recoveries, persistent fistula in 1, and a false anus in 1. There were 29 resections for false anus, 17 of which were successful, 1 failed, and 11 terminated fatally. In 26 cases the false anus was consecutive to gangrenous hernia. Enterectomy followed by enterorraphy, if successful in gangrenous hernia, spares the patient the disgust and misery of ever having a false anus. The indications for practising it are, M. Bouilly considers, the following: 1, when the general condition is such that the patient can stand the operation without syncope, shock, vomiting, or pulmonary congestion; 2, when no general peritonitis and no fecal extravasation into the peritoneal cavity have occurred; 3, when the gangrenous intestine and mesentery can be drawn out, and resection practised in healthy parts of gut; 4, when the calibres of the resected ends are not greatly different. As regards the operation for a false anus, M. Bouilly concludes that the operation is indicated: 1, in cases in which compression, the application of the enterotome, sutures, autoplasty, and other methods of treatment have failed; 2, when the precise condition of the bowel involved cannot be made out, and also, when there is crossing of the ends of the bowel, great inequality in calibre, or several perforations near together; 3, when extensive prolapse of mucous membrane exists, with or without invagination of the subjacent part of intestine; 4, when there is considerable prolapse of one or both ends of the intestine; 5, when a false anus has no spur-like projection between the upper and lower ends of the gut, and there is so large a loss of substance that

¹ Revue de Chirurgie, Mai et Juillet, 1883. See also Am. Journ. of Medical Sciences, October, 1883.

suturing the borders of the opening cannot close it. The description of the operation of enterectomy will be found in the article on Intestinal Obstruction.¹

ENTERO-VAGINAL FISTULÆ.

Communications sometimes occur between a coil of small intestine and the vagina, as a result of injury or disease. Jobert mentions a case in which a contusion of the abdomen was followed by such a fistula. Punctured wounds from the vagina, and ulceration commencing in the mucous coat of the bowel, or following adhesions between intestine and vagina, and set up in some other way, are known causes of entero-vaginal fistula. In other cases, the condition is congenital, and due to an imperforate rectum; but in these the communicating part of the bowel is the large intestine. The sigmoid flexure cæcum, and transverse colon, rarely open into the vagina, but such fistulæ are not impossible.

Symptoms.—These are the discharge of feces per vaginam, and the loathing, inconvenience, and misery, and the interference with sexual intercourse, which such a condition produces.

Treatment.—This may be palliative or curative. The palliative consists in wearing a properly fitting pad or pessary, which should be removed from time to time for cleansing both it and the vagina. If the communication is with the sigmoid flexure or transverse colon, right colotomy would be a preferable substitute. A plastic operation upon the vagina may be tried, but hopes of success cannot be great. If all other measures fail, and the fistula is large enough to allow of a free escape of fecal matter into the vagina, and to give rise to great discomfort, or perhaps, even to danger, enterectomy and circular suture, by abdominal section, should certainly be performed. The subject of recto-vaginal fistula is dealt with in other articles.

FOREIGN BODIES IN THE STOMACH AND INTESTINES.

By "foreign bodies" are meant such as are incapable of being influenced by the digestive processes. Poland² groups them under the following heads:—

(1) Pointed bodies, such as needles and pins. (2) Elongated, irregular and cutting bodies, such as false teeth, egg-cups, heel-plates of boots, tin-tacks, knives, scissors, forks, spoons, blades, awls, bodkins, nails, slate-pencils, etc. (3) Rounded bodies, such as coins, thimbles, marbles, bullets, and fruit-stones. These are more easily got rid of by passing along the intestinal tube than those of either the first or second class. To these we must add: (4) Hair, wool, cocoa-nut fibre, etc., which are apt to accumulate and become matted together into large, firm, rounded balls.

The *symptoms* which are excited, vary according to the nature and number of the foreign substances. Sometimes the bodies will produce little or no in-

¹ Reference should be made for information on this subject to the celebrated essay by Dupuytren, in his *Leçons Orales de Clinique Chirurgicale*; to Jobert's work, *Maladies Chirurgicales du Canal Intestinal*, tome ii. p. 80; to Mr. Teale's article on Intestinal Fistula, in the 2d volume of Costello's *Cyclopedia of Practical Surgery*; to Prof. S. D. Gross's excellent work on *Wounds of the Intestines*, chapter iv.; to Sabatier's *Mémoire sur les anus contre nature*, in the *Mém. de l'Acad. Royale de Chir.*, tome v. p. 592. 1774; to Scarpa's *Treatise on Hernia*, translated by J. H. Wishart; to the *Dictionnaire de Médecine*, 1833, article "Anus Contre Nature;" to Dupuytren's article in the *Dict. de Médecine et de Chirurgie Pratiques*, tome iii. p. 267, and to many other French and German works to which references will be found in the above named works.

² Prize Essay.

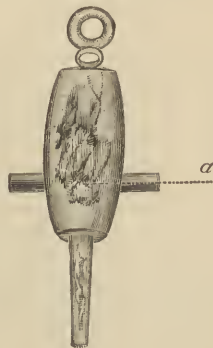
convenience, but will pass on through the whole intestinal tract and be discharged *per anum*. Sometimes they remain for a long time, or throughout the rest of life, without giving rise to any marked discomfort. In other instances, especially if the bodies be pointed, they set up inflammation of the stomach or bowels, cause ulceration of their coats, or pierce them and excite general, or circumscribed peritonitis; or, after leading to adhesions between viscera and parietes, they may induce parietal abscesses. Occasionally they escape entire through the abdominal wall, or are removed by the patient or surgeon after having partially passed through it.

FOREIGN BODIES IN THE STOMACH.—As a rule, the first symptoms are vomiting and pain in the epigastrium; succeeded by a sense of weight and fulness, attacks of indigestion, and very possibly, if the parietes are thin, by the detection, on external manipulation, of the presence of the foreign body. Hæmatemesis occasionally occurs, and sometimes acute gastritis. In other instances, after a long period of pain, indigestion, loss of appetite, and sense of weight or oppression at the pit of the stomach, the patient dies of exhaustion.

In some of the reported cases it is quite astounding to observe how many and what large-sized substances have been discovered in the stomach after death, and that, despite their presence for months or years, the persons have died from other causes. In some instances, large numbers of pins or needles are said to have been swallowed, and afterwards eliminated, separately and spontaneously, at different parts of the body; but such statements, made as they generally have been by hysterical women, must be received with caution,¹ though possibly not with such absolute incredulity as the statement of the man who, having swallowed a half-sovereign in gold, asserted positively that he had expelled it *per anum* in half-penny and penny pieces. Artificial teeth are the bodies most commonly swallowed by accident, and they are now so generally worn that I never suffer an anæsthetic to be administered without previously ascertaining that the patient either does not wear artificial teeth or tooth-plates, or has removed them.

Many of the persons who swallow foreign bodies, not by accident, are insane or thieves. Jugglers have often swallowed them accidentally, and thieves intentionally; others again have had the substances forced down their throats. No articles are so frequently swallowed by thieves as coins, and these usually pass on into the stomach and bowels without any mishap. Occasionally a thief attempts to get rid of a more bulky booty. There is in the museum of the Middlesex Hospital a specimen showing an entire mutton-chop, impacted in the pharynx opposite the back of the larynx; death was instantaneous. The man had endeavored to bolt the morsel whole, in a tavern close to the hospital. Knives and other steel and iron bodies, when retained for some time in the stomach, undergo a slight degree of solvent action; this has been proved by the loss in weight of the retained bodies, and by the ferruginous staining of the stools. I am aware of a case in which a school-boy swallowed an aluminum pencil-case of telescopic make, such as is worn as a trinket; it was swallowed in its

Fig. 1210.



Cannon-shaped pencil passed by the rectum; *a*, patches of erosion. (Half-size.)

¹ See an interesting paper on this subject by Mr. Alban Doran, in *St. Barth. Hosp. Rep.*, vol. xii. pp. 118 *et seq.*

closed state, and thus measured about 4 inches; thick soups, pudding, and bread, were partaken of freely, and in five days the foreign body was passed *per anum*, much changed in appearance from the action of the gastro-intestinal secretions, which had freely acted upon it, and even upon the lead which it contained when swallowed. The case was brought to my notice by a former pupil, Mr. W. H. Forbes, to whom I am indebted for the accompanying drawing of the pencil-case after its discharge from the bowel. M. Hévin, in his exhaustive memoir, has related some very interesting cases of persons who had swallowed knives, etc., and whose stomachs were opened for the removal of the foreign substances. Poland has collected six very interesting cases of foreign bodies in the stomach:—

One is the case, described by Dr. Marcet,¹ of the sailor who between June, 1799, and his death in Guy's Hospital in March, 1809, from perforation of the stomach, swallowed a large number of clasped knives, several of which he passed *per anum* and others of which he vomited. The stomach, with between thirty and forty fragments of knives, was removed after death, and is now in Guy's Hospital Museum. Another case is related by Dr. Barnes, of Carlisle, of a juggler, who on November 17, 1823, accidentally swallowed a table knife with a bone handle, together about 9 inches in length. It remained quiet until January 16, 1829, when he died of gangrene of the duodenum, caused by pressure of the lower end—the handle—of the knife. This knife is in the museum of the College of Surgeons, London. The third case is that of a man, aged 23, a patient in the Peckham House Lunatic Asylum, who swallowed several spoons and spoon-handles, and died, after an interval of five months, from peritonitis and perforation of the duodenum. Thirty-one entire spoon-handles, about 5 inches long, besides four half handles, nine nails, half of the iron heel of a shoe, one screw, four pebbles, and one button—making together a mass weighing 2 pounds 8 ounces—were found in the stomach and duodenum. In the other three cases referred to by Poland, gastro-tomy was performed successfully, and in each instance the foreign body was a knife.

On the 9th of April, 1876, M. Labbé removed by gastrotomy a fork, which had been in the stomach of a man, aged 20 years, for two years:—

An incision, four centimetres long, was made along the borders of the ribs, and the stomach, before it was opened, was attached to the abdominal parietes by eight points of suture, passed by highly curved needles at a distance of a centimetre from the circumference of the external wound. On the fifth day after the operation the patient began to take solid food, and the aperture into the stomach was quickly reduced to a mere fistula. M. Labbé lays great stress on the importance of fixing the stomach to the abdominal parietes before opening it.²

Sometimes foreign bodies, such as pieces of wool, cloth, string, etc., are swallowed by hysterical women and then vomited at will, to the astonishment and alarm of their friends. Dr. Cobbold has mentioned the case of a lady who consulted him on account of an affliction, which she described as “the worm that dieth not.” It appeared, she said, frequently in her vomit. On examination “the worms” proved to be small fragments of differently colored wools which she had swallowed.³

Treatment.—Aperients, so often resorted to in these cases, should be avoided. If the foreign body be one likely to pass through the canal, rest in the horizontal position, and the use of food adapted to form a soft, pultaceous surrounding, should be enjoined. Thick soup, farinaceous puddings, eggs, etc., should be taken, and then, at the end of four or five days, if the foreign sub-

¹ Med.-Chir. Trans., vol. xii. p. 52.

² Gazette Hebdom., 5 Mai, 1876; also, Am. Journ. Med. Sciences, July, 1876, p. 279.

³ Cases of much interest are related in Bryant's Manual for the Practice of Surgery, and by Pollock, in the article on Injuries of the Abdomen, in the System of Surgery edited by Holmes and Hulke; and for a list of published cases of foreign bodies in the digestive canal, the reader may refer to an article by Dr. Mignon in the Union Médicale, Nov. 1874.

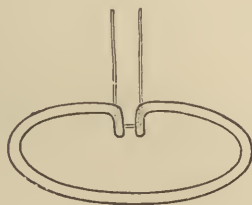
stance has not escaped *per anum*, its exit may be assisted by a cathartic. Should the substance become fixed across the rectum, gentle and well-directed efforts should be made to extract it. When from its character it is unlikely to pass through the pylorus, or is certain to damage any part of the tube in which it remains, gastrotomy should be advised, and its performance not too long delayed. It must be borne in mind, however, when considering this operation, that many extraordinary recoveries have occurred after the expulsion *per anum* of numerous and awkwardly shaped foreign bodies; but though these cases should make the surgeon deliberate, nothing should cause him to delay, after well making up his mind that the probabilities are all against spontaneous expulsion, and in favor of dangerous retention.

Gastrotomy is to be distinguished from *gastrostomy*. The former is the name given to the operation of opening the stomach with the object of removing a foreign body, and then closing the wound in the stomach, replacing the viscus, and sewing up the external wound with the hope that the patient will return to health and safety, and the stomach to a perfectly normal condition. *Gastrostomy*, on the other hand, is designed to rescue a person from starvation by making a permanent opening, or artificial mouth, by attaching the walls of the stomach to the abdominal parietes, when from any cause the natural food-channel is obstructed. Both these operations are to be distinguished from a third, sometimes wrongly called gastrotomy, namely the division of the abdominal parietes for exploratory or operative purposes, a procedure to which the term *laparotomy* is now applied.¹

Gastrotomy must be looked upon as a very successful operation. It is performed in the following manner:—

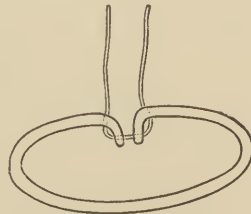
An incision is to be made over the stomach, by carefully cutting through the different strata of the abdominal wall in either a longitudinal or oblique direction, until the peritoneum is reached; the peritoneum should then be punctured, and carefully divided upon a director introduced through the punctured opening. The foreign body should now be felt for by passing the finger tip over the surface of the stomach; the stomach should be raised into the wound by forceps, or by a ligature looped through the peritoneal and muscular coats; and then an opening should be made into the stomach thus

Fig. 1211.



Lembert's suture.

Fig. 1212.



Jobert's suture.

fixed, just sufficiently large to allow of the extraction of the foreign body without bruising or tearing the parietes of the viscus. The extraction can be

¹ *Gastrorrhaphy* and *enterorrhaphy* are the closure of wounds of the stomach and intestine respectively by means of sutures, after refreshing the bruised edges of the wounded viscus—a proceeding which, as has been observed, is quite unnecessary in the modern practice of applying sutures to the alimentary canal, whereby inversion and apposition of the serous surfaces are always sought.

effected by a pair of polypus forceps, or by a blunt hook, according to the shape of the foreign body; after its withdrawal, the stomach-wound should be stitched up with a continuous, or Lembert's (Fig. 1211), or Jobert's (Fig. 1212), suture; and the wound in the abdomen should be closed as after ovariectomy. For two days prior to the operation as little food as possible should be taken into the stomach.

If the oblique incision be employed, it should commence below and a little to the left of the xiphoid cartilage, and should be continued for three and a half inches outward, and an inch below the margin of the costal cartilages. If the longitudinal incision be selected, it should be made four inches in length along the outer edge of the left rectus muscle, beginning immediately below the margin of the thorax. Great care must be taken against blood or gastric contents escaping into the peritoneal cavity, and with this object all bleeding from the cut edges of the parietes should be stayed before opening the peritoneum, and all bleeding from the cut edges of the stomach before introducing the sutures. The looped ligature, by allowing upward traction to be made upon the stomach, will help to prevent any escape of its contents, and this may still further be secured by taking care to have an empty stomach at the time of operating. M. Labbé fixed the stomach to the opening in the abdominal wall by eight points of suture before cutting into the viscus, and attached great importance to this step in his successful case above referred to. The after-treatment consists in keeping the shoulders and knees of the patient raised, applying a soft, light dressing, such as absorbent cotton-wool, or boracic charpie, and retaining it with a broad flannel binder. No food should be given by the mouth for three or four days, but the patient should be sustained by nutritive enemata.

Pooley,¹ of New York, and Durham² have shown that in nine out of ten cases of gastrotomy recovery has taken place. To the earlier cases tabulated by Mr. Durham, he has since added Labbé's case read before the French Academy of Medicine in 1876; Fleury's case, in which a fork, accidentally swallowed, was removed two days afterwards;³ and the fatal case of Billé, in which gastrotomy was performed subsequently to œsophagotomy. Still other cases have been recently recorded by Félizet,⁴ [Schönborn, Thornton, Billroth, Gussenbauer, Kocher, Credé, and Stelzner.]

[The following is believed to be a correct list of the operations hitherto reported for removal of foreign bodies from the stomach. Dr. Otis has clearly shown that Mr. Durham, following South, is in error in attributing a successful case to "Shoval," the case in question being identical with that of Schwabe. (See Table on page 589.)

Of the 18 cases of undoubted authenticity here tabulated, 14 are known to have been successful, and a fifteenth (Félizet's) would have been equally so, but for imprudence in diet on the part of the patient.]

FOREIGN BODIES IN THE INTESTINES.—Foreign bodies may enter the bowel in the following ways:—

¹ Pooley, Richmond and Louisville Med. Journal, April, 1875.

² Durham, Holmes's System of Surgery, 3d ed., vol. i. p. 799.

³ Garnier, Dict. Prog. des Sciences Médicales, Paris, 1882.

⁴ Much information on gastrotomy will be found in the second surgical volume (pp. 58 and 59) of the Medical and Surgical History of the War of the Rebellion, to which I must refer the reader for references to all the known cases and sources of information. The editor of the History remarks that "in the single example of lodgment of a ball in the cavity of the stomach, recorded during the war, there was no question of gastrotomy, an operation unlikely to be called for in military surgery."

Operator or reporter.	Result.	Reference.
Mathis,	Recovery,	Otis, Med. and Surg. Hist., etc., Second Surg. Vol.
Hübner,	do.	Ibid. [p. 59.
Schwabe,	do.	Ibid.
Cayroche,	do.	Ibid.
Dr. L——,	do.	Ibid.
Bell,	do.	Ibid.
Glück,	Death,	Ibid.
Labbé,	Recovery,	Gazette Hebdomadaire, 5 Mai, 1876.
Fleury,	do.	Garnier, Dict. Prog. des Sc. Méd., 1882.
Billé,	Death,	Berlin. klin. Wochenschrift, 1880.
Félizet,	do.	Deutsch. med. Zeitschrift, and Cinc. Lancet and Clinic,
Schönborn,	Recovery,	Medical Record, May 19, 1883. [Feb. 3, 1883.
Thornton,	do.	British Med. Journal, May 10, and July 5, 1884.
Kocher,	do.	British Medical Journal, July 12, 1884.
Billroth,	do.	Medical News, April 18, 1885.
Gussenbauer,	Death,	Revue des Sciences Médicales, t. xxv. p. 305.
Crédé,	Recovery,	British Medical Journal, July 4, 1885.
Stelzner,	do.	Ibid., April 30, 1887.
(Doubtful cases.)		
Frisac,	Recovery,	Otis, op. cit.
Bouisson,	do.	Ibid.
Garcia,	do.	Ibid.
New,	do.	Ibid.
Ewing,	do.	Ibid.

1. They may be swallowed and passed on through the pylorus. It is rare for bodies which have reached the gut in this way to become lodged within it, but it occasionally happens. Reference has already been made to a case in which the handle of a knife, seven inches long, passed into the duodenum and caused sloughing of its front wall. There are not a few instances on record in which fruit-stones have become impacted in the cæcal appendix. Fish-bones and particles of chicken and other bones become impacted in the walls of the bowel, and there set up abscess. I saw the late Mr. De Morgan remove a slender piece of bone from a fistula in ano which he was laying open; the evidence went to show that it had been swallowed, not introduced from below. Again, things like wool, hair, husks of oats, cocoanut-fibre, etc., swallowed little by little, may in time accumulate in the bowel and cause obstruction.¹

2. After ulceration, biliary calculi, pancreatic calculi, renal calculi, and hydatids from the kidney and other solid organs, may enter the bowel and either give rise to obstruction or be discharged *per anum*.

3. Foreign bodies are not infrequently introduced into the rectum by the patients themselves, and there become impacted, or penetrate the walls of the rectum and enter the bladder, vagina, peritoneal cavity, or some coil of bowel which has descended into the pelvis. It is possible that they may sometimes work upwards even as high as the cæcum.²

4. Bullets enter the intestine after penetrating the abdominal walls, but

¹ Dr. Down, Trans. Path. Soc. Lond., 1867; Bryant, op. cit., 3d ed., vol. i. p. 616.

² Holmes, Principles and Practice of Surgery, 3d ed., p. 215. 1882.

they generally pass *per anum*, being seldom retained in the gut. Hennen records a typical case.¹

The *subsequent careers* of foreign bodies which have entered the intestine are various. (1) They may remain without giving rise to any, or but slight if any, inconvenience. Mr. Marshall² has recorded a very remarkable case in which a pound of pins was found in the duodenum, and nine ounces in the stomach, of a woman who during life had experienced attacks of gastric irritation. The pins had been accumulating at least five years, and at length the duodenum had become impassable.

(2) They may penetrate and be discharged through the abdominal walls, either after causing an abscess in the parietes, or after simply leading to adhesions between the bowel and parietal peritoneum. Poland mentions the case of a boy, aged 14, who had had scarlet fever and dropsy, followed by an abscess which burst at the umbilicus. A plum-stone escaped through the fistulous opening.

(3) They may pass *per anum*. Hager gives an instance of a young woman, aged 25, who vomited several pins, and passed several others with her stools. Mr. Callender³ recorded a case of intestinal obstruction due to the impaction of a gall-stone. On the twelfth day of the symptoms the bowels acted spontaneously, and a calculus weighing 1 oz. 13 grs., and measuring 2 inches in length by 1½ inches in width, passed through the anus with some difficulty.

(4) They may penetrate or ulcerate through the walls of the bowel, and escape into the general cavity of the peritoneum, or into some other important viscus or structure, such as the vena cava or aorta.

(5) They may become impacted in the bowel and destroy life by intestinal obstruction; or, after months or years of pain and dyspepsia, by chronic ulceration of the gut set up by the foreign body as it gradually passes along the canal. A good instance of intestinal obstruction from gall-stone occurred in the Middlesex Hospital, and the specimen is in our museum. It consists of a portion of the middle of the ileum, with a large and almost spherical gall-stone nearly four inches in circumference; it has been sawn in half, and the upper fragment removed, and in this situation the mucous membrane of the intestine has ulcerated away, and above this the bowel is dilated and its peritoneal coat is partly covered by lymph. The gall-stone entered the duodenum through an ulcerated opening. The patient, a woman aged 46, died after ten days of vomiting and constipation.⁴ Five cases of intestinal obstruction from gall-stone were collected by Marrotte, and communicated by him to the Medical Society of the Paris Hospitals, in 1856. Drs. Abercrombie and Oke⁵ have reported three others, and Mr. Swaine and Mr. Appleton⁶ have each recorded one case. In Mr. Swaine's, the calculus was impacted just above the ileo-cæcal valve. In Mr. Appleton's, there was an intussusception of the ileum just below the impacted calculus. Mr. Arthur E. Barker has recorded a very interesting case of death from intestinal obstruction, due to the impaction of a large biliary calculus in the upper part of the ileum, in front of the left iliac region. The stone was 4 inches by 4½ inches, and weighed over 5 drachms; and 14 or 15 other large biliary calculi were found in the intestines above the point of obstruction, and in the circumscribed, sloughing abscess-cavity which had been formed about, and which in large part had destroyed, the gall-bladder.⁷ The gall-stones had entered the intes-

¹ Op. cit., p. 408, Case LXV.

² Med.-Chir. Trans., vol. xxxv. p. 65.

³ Trans. Clinical Soc., vol. vi. p. 193.

⁴ For full report of case, by Dr. Vander Byl, see Trans. Path. Soc. Lond., vol. vii. p. 23.

⁵ Brit. Med. Journ., May 20, 1853.

⁶ Ibid., vol. i. 1857.

⁷ Trans. Path. Soc. Lond., vol. xxix. p. 142.

tine through an opening on the right side of the second part of the duodenum. Langstaff relates the case of a mad-man who after swallowing a silver table-spoon began to suffer from dyspepsia, frequent and acute pain in the region of the cæcum and colon, diarrhœa, and the frequent discharge *per anum* of blood and pus. Ascites and other symptoms of diseased liver came on, and he was tapped; after this the spoon, which the patient had often said he could feel moving about, was detected in the situation of the cæcum through the abdominal parietes, but no attempt was made to remove it by enterotomy. The man died about twenty months after the tapping, and at the post-mortem examination the mucous membrane of the stomach, duodenum, jejunum, ileum, and cæcum, presented evident marks of ulceration at different points. The greatest mischief had been inflicted by the passage of the spoon through the ileo-cæcal orifice, which was much dilated; and the mucous membrane of the cæcum was nearly destroyed by ulceration. The spoon was found at this part, with the bowl downwards, having formed a large pouch which had checked its further progress. The preparation is in the Hunterian Museum.

Foreign bodies in the appendix vermiformis are by no means rare. Poland mentions the case of a girl, aged twelve, who after a few days of general weakness and loss of appetite was found dead in bed. There were extensive puriform peritonitis, and ulceration of the vermiform process, in which was found a small, leaden, foreign body making its way through. Dr. Peacock described at the London Medical Society the case of a clergyman, who, after symptoms simulating hernia, had an abscess form in the right iliac region, from which a cherry-stone came away. He died subsequently of some other disease.

Some years ago I saw, in the practice of my father, a young lady aged eighteen suffering from the most intense peritonitis, with symptoms suggestive of intestinal obstruction; she died, and on examination a damson-stone was found in the appendix cæci, the extremity of which was destroyed.

Foreign bodies other than those swallowed are at times found in the appendix, such as biliary concretions, and small, hardened masses of feces. All these cases for the most part end fatally, from acute suppurative peritonitis set up by ulceration and perforation of the coats of the appendix.

Foreign bodies are not often lodged in the *large bowel*, though they occasionally become impacted when introduced through the anus. There are, however, three conditions under which a foreign body which has passed through the length of the alimentary canal may become retained in the colon, sigmoid flexure, or rectum; these are (1) when solid fecal matter is deposited around the foreign body; (2) when owing to its shape the foreign body sticks into the wall of the gut, or becomes fixed across its lumen; and (3) when any constriction of the bowel exists, whether this be due to some form of stricture, or to adhesions, adventitious bands, pressure of a tumor, or other cause. Mr. Clement,¹ of Shewsbury, has recorded a case in point:—

A lady who for fourteen days had suffered from complete constipation and the symptoms usually attendant on strangulated hernia, had her colon opened in the right loin. After recovery from the operation, a mass consisting of five plum-stones, agglutinated together, was shot out through the artificial anus. Subsequently, and at intervals, other plum-stones were discharged, until the total number amounted to 116. She died three years after the operation, and there was found at the junction of the ascending and transverse colon a most rigid stricture—not quite a quarter of an inch wide, perfectly smooth, and of pearly whiteness—looking just as if a piece of whipcord had been firmly tied around this part of the intestine. The stricture was of cartilaginous hardness, and the occlusion so complete that not even a bristle could be passed through it.

¹ Med.-Chir. Trans., vol. xxxv.

Treatment.—Enterotomy should be performed if the foreign body becomes impacted, and life is threatened either from obstruction or perforation, or is rendered miserable and useless as the result of the foreign body's continued presence in the bowel; also if the foreign body be such as is not likely to pass the ileo-cæcal valve and cæcum, and especially if it be long and of angular shape.

In the American Journal of the Medical Sciences¹ is an account of an interesting case in which a silver spoon was successfully removed by enterotomy from the small intestine of a man aged twenty-six years, one calendar month after it had been swallowed; the intestine, after the extraction of the spoon, was sewn up and returned. The operation was performed on Aug. 7, 1806, by Dr. White, Senior, of Hudson, N. Y., who published an account of it in the Medical Repository.²

Mr. Bryant³ relates a case of acute intestinal obstruction due to a gall-stone, which had entered the duodenum by ulceration of its coats. This stone, which weighed 238 grains and measured three and one-quarter inches in circumference, had become impacted in the ileum about a foot above the ileo-cæcal valve, and was removed by enterotomy by Mr. Bryant. Unfortunately the patient died from peritonitis, which had commenced before the operation was performed.

Enterotomy.—This operation consists in cutting through the abdominal parietes in the middle line, if the exact position of the foreign body is unknown, but along the linea semilunaris, or in one of the iliac regions, or at any other spot near to or over the foreign body, if it can be felt through the abdominal walls. The portion of intestine in which the foreign body is lodged should be drawn to the surface of the wound, and carefully surrounded with properly prepared sponges, so that nothing may escape from the incised gut into the peritoneal cavity. Next, the bowel should be opened by as small an incision as possible, and the foreign body removed by polypus or claw forceps, or with the finger and thumb. The wound in the gut is then to be sewn up by Lembert's, Jobert's, or the continuous suture. Finally, the gut should be returned into the abdomen, and the parietal wound closed by interrupted sutures of silk or fishing-gut, passed through all the layers of the abdominal walls, including the peritoneum. The wound should be dressed as after ovariectomy and gastrotomy, and the after-treatment should be the same. If the foreign body be impacted in the cæcum, the operation just described should be performed, the external incision being made in the right iliac region. In certain cases of impaction in the large intestine, *colotomy* will be indicated, and may be followed by the exit of the impacted substance, as well as by complete relief of the intestinal obstruction. Mr. Clement's case has been already cited to illustrate this fact. In June, 1880, M. Verneuil brought before the Society of Surgery, in Paris, the case of a man aged forty, who had introduced a piece of wood into his lower bowel to check diarrhoea. The foreign body, a few days afterwards, was above the reach of the hand in the rectum, so laparotomy in the median line was performed, and the foreign body was pushed downwards along the bowel until it could be seized in the rectum and withdrawn *per vias naturales*. The man recovered well. Hévin mentions an ingenious device which was resorted to by Marchetti. Some students had pushed a pig's tail, previously frozen hard and with the hair cut short, into the rectum of a lewd woman. The hairs sticking in the gut resisted all attempts at removal, until Marchetti introduced a hollow tube over the pig's tail, and brought the tube away with the tail included in it.

¹ Loc. cit., July, 1876, p. 279.

² Loc. cit., Second Hexade, vol. iv. p. 367.

³ Trans. Clin. Soc., vol. xii. p. 106.

LOOSE AND FOREIGN BODIES IN THE PERITONEUM.

Besides such morbid contents as blood and air, other substances are found free in the peritoneal cavity, such as gall-stones and intestinal concretions which have escaped by ulceration. These, however, when they do not cause fatal peritonitis, become encysted by adhesions, rather than continue quite free and unconfined in the cavity. Loose bodies, of size varying from that of a bean to that of a pigeon's egg, are occasionally met with in the general cavity of the peritoneum, and may be of several kinds: (1) Growths connected with the intestine by long, thread-like pedicles, or cast entirely off; (2) appendices epiploicæ, as pointed out by Mr. Shaw; (3) loose earthy and calcareous bodies, probably detached and degenerate mesenteric glands, as in Case CCXXXI. given by Habershon; (4) coagula of blood, which after clotting have been organized into fibrinous masses; (5) detached uterine myomata;¹ (6) portions of large fatty tumors, which have undergone fibrous and osseous transformation, and have then become separated from the original mass.² Such loose bodies may get into a hernial sac and give rise to symptoms of hernia.

Foreign bodies introduced from without, sometimes lodge a long time in the peritoneum. One of the most extraordinary cases of this sort has quite recently been recorded by Thorndike:—³

A sailor, aged 41, was in the habit of pushing an 8-ounce bottle into the rectum to overcome retention of urine due to spasm. On one occasion, not having a bottle, he introduced a pebble 5 inches by 3 inches in magnitude; the stone slipped up beyond the sphincter; the captain's boy tried to remove it by pushing his hand up after it "as high as the shoulder;" two days afterwards laparotomy along the outer border of the left rectus was performed, and the stone, which was found lying among the intestines just below the stomach, was removed. The patient made a good recovery.

ABDOMINAL ABSCESES.

Abdominal abscesses are of four kinds: (1) Those between, and on the exterior of, the viscera of the abdomen; these are often, but by no means always, the consequence of abdominal injuries which have given rise to localized peritonitis. (2) Visceral abscesses, or those which have originated in, and, for a time at least if not throughout the whole of their course, are confined to, the interior of some one organ; such are the hepatic, splenic, renal, omental, and biliary abscesses. (3) Parietal abscesses, or those which occur from various causes between the layers of the abdominal parietes. (4) Retro-peritoneal abscesses. The last two varieties having been already considered, we have now to describe only the first two.

PERITONEAL ABSCESES are of two kinds, the circumscribed and the diffused.

1. The abscesses which are exterior to the organs, and yet circumscribed, occur in all parts of the abdominal and pelvic cavities, and are walled in by fibrinous adhesions between viscera and parietes, or between two or more of the viscera, or two or more coils of the intestine. Such cases are of great interest and importance in regard to both diagnosis and treatment; but they vary so greatly from one another in their symptoms, course, and pathological

¹ Eve, Trans. Path. Soc. Lond., vol. xxxi. p. 316.

² Dreschfeld, *ibid.*, vol. xxxi. p. 287.

³ Medical and Surgical Reports of the Boston City Hospital, 3d series, 1882.

anatomy, that it is to a great extent impossible to group them, and each seems to stand aloof from the others, as an isolated, or at any rate as an exceptional condition. On this account, and because too, as Dr. Fagge¹ has remarked, they do not yield specimens which can be shown to advantage at a Pathological Society, they have not succeeded in gaining for themselves a place in systematic works on medicine or surgery. It is well, therefore, to refer to them, since, doing so "must necessarily suggest to the mind of every reader, the important fact that in practice the abdomen may be found affected with other diseases besides those which are ordinarily enumerated under the heading of diagnosis in a treatise on medicine." (Fagge.)

Causes.—Peritonitis, which may even have been general, leads in some part of the abdominal cavity to a circumscribed collection of pus, and it is not always easy to say whether the peritonitis has been idiopathic, or due to some local cause, even though search be made after death.

Often, however, there is a definite history of a blow, kick, sprain, or other injury having excited the peritonitis, and in some cases it has been ascertained that the injury had ruptured some part of the abdominal organs.² In other cases, the peritonitis has followed some accident of parturition, and has left behind an abscess in some distant part of the abdomen; or an abscess in the left hypochondrium has resulted from a general puerperal peritonitis. (Fagge, Case II.) Other causes have been cancer of the stomach or intestines, simple and dysenteric ulcers of the gastro-intestinal tube, gall-stones, and various other conditions which have led to inflammation with adhesions, and then to suppuration of the surrounding or adjacent peritoneum. Sometimes a visceral abscess situated near the surface of the organ will give rise to a circumscribed peritoneal abscess. I have before me now the post-mortem record of a case in the Middlesex Hospital, in which dysenteric ulceration of the colon had given rise to multiple hepatic abscesses, mostly near the surface of the liver, these in turn having caused a large circumscribed peri-hepatic abscess between the diaphragm and liver, the convex surface of which organ had been so pressed upon by the outside abscess as to have become concave. Diseases connected with the appendix cæci,³ the ovaries, uterus, bladder, or kidneys, are other exciting causes, and the abscesses thus excited may or may not open into the colon, rectum, sigmoid flexure, cæcum, vagina, or bladder. I have repeatedly had under my care patients with uterine cancer, who, in the later stages of their illness, have suffered from peritonitic pain and tenderness, and from the formation of a prominent and hard tumor in the hypogastrium; at the post-mortem examination the uterus is found to have been more or less—sometimes entirely—removed by ulceration, when a large abscess-cavity, with stinking, ill-colored, turbid, fluid contents occupies its place. This offensive cavity is shut off from the general peritoneal cavity by coils of small intestine matted together, so as to form its roof. There is beside, in these cases, general peritonitis, and though, from the character of the matter, fecal extravasation is suggested, this is commonly demonstrated not to have been present. I am now quite alive to this condition, and should always suspect it in cases of uterine cancer where there has been much discharge, and where a hypogastric tumor, developing in the late stage, is attended by

¹ Cases of Abscess within the upper part of the Abdomen. Guy's Hospital Reports, 3d series, vol. xix. p. 213.

² See a case recorded by Mr. Cesar Hawkins (Trans. Path. Soc. Lond., vol. i. p. 150), in which there were two circumscribed peritoneal abscesses, one fecal, and the other, in the left hypochondrium, communicating with an abscess in the left pleural cavity through a traumatic rupture of the diaphragm.

³ See a case by Dr. F. Taylor, in Guy's Hosp. Reports, vol. xix. p. 266. Several circumscribed collections of pus were found within the peritoneal cavity, and due to this cause.

more or less constant abdominal pain and tenderness. Ovarian tumors of a non-malignant type sometimes co-exist with cancer of the uterus, but their characters are sufficiently distinct not to require to be diagnosed from the encysted abscesses referred to.

Course and Symptoms.—Circumscribed peritoneal abscesses may occur at any age, from childhood upwards; they may also occupy any part of the peritoneal cavity, and they are often multiple. Probably the commonest, and some of the most important cases, are those situated in the right and left hypochondria, that is, between the liver and the diaphragm, and between the spleen and stomach and the diaphragm. In the valuable article referred to, Dr. Fagge has described sixteen cases of this sort; in six the abscess was between the liver and the diaphragm, and in ten in the left hypochondrium. In five of the six supra-hepatic cases the pus was over the right lobe of the liver; in the other, the abscess was on the convex surface of the left lobe, and there was a perforation through the diaphragm into the left pleural cavity.

In a large proportion of hypochondrial abscesses, the corresponding side of the thorax becomes affected; pleurisy, pneumonia, pleuritic effusion, or empyema, results: and the case is very likely to be mistaken for one of thoracic disease, whilst the abdominal abscess is overlooked. The course of such cases is frequently this: the liver or spleen is injured, perhaps ruptured, or perhaps the capsule is stretched, not actually torn; this is followed by local peritonitis terminating in abscess beneath the diaphragm; then pleurisy is set up, followed by adhesion of the base of the lung to the diaphragm, and, inflammation spreading, effusion takes place, and the lung is compressed against the spine by the increasing effusion of serum; at a later period the abscess bursts through the diaphragm, and opens into the adherent lung, or into the lung and pleural cavity as well, and then an empyema is established. If the abscess is on the left side, pericarditis as well as pleurisy may be excited. In cases in which cancer, ulcer, or any other pathological condition excites these sub-diaphragmatic or hypochondrial abscesses, the course of the case may be just the same as above described. In other cases, again, the abscess may discharge itself into the stomach or transverse colon, and air may enter the abscess from the bowel; when this happens in the left sub-diaphragmatic abscess, each beat of the heart may give a splashing sound, as in a case described by Fagge (Case VII.).

Sometimes an abscess will open at a number of different points into the gastro-intestinal tube:—

A woman, aged thirty-three, suffering from tubercular peritonitis, was under the care of Dr. Coupland, in the Middlesex Hospital, in November, 1880. She died, and at the post-mortem examination an abscess-cavity was found, containing fetid gas, and semi-purulent and partly feculent matter. The abscess was bounded in front by the posterior wall of the stomach, and below by the collapsed transverse colon and some coils of ileum; two perforations existed in the ileum, and three in the upper and anterior wall of the colon, within an area of two square inches; each of these openings was large enough to admit an ordinary cedar pencil, and all had clearly been formed by ulceration extending from the serous towards the mucous coats. In no other part of the intestine was there any ulceration of the mucous membrane. The stomach was inseparably adherent to the liver, spleen, colon, and parietes; and numerous opaque, flattened, tubercular nodules studded the peritoneum. There was no fluid in the general peritoneal cavity.

The symptoms of circumscribed peritoneal abscesses so vary with the cause and condition of the patient, that it is not possible to mention definitely any which are common to all cases. Probably, though by no means certainly,

there will be evidence of severe inflammation, with rigors, following an injury; or coming on in the course of some illness connected with one or other of the abdominal organs. There will be high fever, local tenderness, and increased dulness on percussion, and in a short time a tumor may show itself. Sometimes the swelling is visible below the edges of the lower ribs, sometimes in the epigastrium, or in the lumbar region. In not a few cases there have been intermittent attacks of severe abdominal pain, tenderness, and tympanites, attended with general symptoms of fever or of aguish attacks; dyspepsia, provoked by the implication of the sympathetic nerves and ganglia in the surrounding inflammation; constipation and sickness; and sometimes vomiting of blood-stained fluid or of blood.

Such symptoms, occurring after a period of some abdominal ailment, or of fixed abdominal pain of long duration—or themselves extending over many weeks or months, or perhaps recurring at intervals during a year or two—should make the surgeon suspicious that abdominal abscess exists somewhere, though there may be nothing to point definitely to the seat of the mischief, and though, too often, surgical aid could not avail if an exact diagnosis were formed. Much the same sort of symptoms are caused by retro-peritoneal abscesses, and in some cases, such as those in which suppuration is excited by ulcers of the duodenum, strictures of the œsophagus near the stomach, pancreatic calculi, etc.—in which tactile and ocular demonstrations are not possible—it is quite out of the question to be able to say whether the abscess is behind or within the peritoneum, or both. In many respects, some of the abscesses between the diaphragm and liver resemble hepatic abscesses, and those between the diaphragm and spleen resemble splenic abscesses.

Diagnosis.—From retro-peritoneal and perinephric abscesses, from hepatic, splenic, and renal abscesses, from hydronephrosis, abdominal cysts, aneurisms, accumulations of extravasated blood, and malignant and other tumors, these intra-peritoneal abscesses have to be distinguished. Sometimes, in the diaphragmatic abscesses, the chest symptoms, after the first few days, altogether overshadow the abdominal, and thus lead to errors in diagnosis; even on post-mortem examination, there is occasionally room for difference of opinion as to whether such an abscess has caused empyema, or an empyema the abscess; in other cases it is quite as difficult to decide whether an abscess has been peri-hepatic or peri-splenic in its origin, and has involved the viscus in its progress, or whether its starting-point has not been in the substance of the organ. C. Zuber¹ reports two cases of peri-splenic collection, one of which had not been detected during life as there were no symptoms pointing attention to the left side, while the other was wrongly diagnosed to be a case of intra-abdominal malignant disease. Neither the error in diagnosis nor the post-mortem surprise is a very rare thing in such cases.

Attention must therefore be given to the previous history, onset, and earlier symptoms of these obscure cases; and if it be borne in mind that they very frequently, perhaps generally, result from direct external injury, or by extension from some disease in a neighboring organ, a correct diagnosis may often be made. The character of the tumor, when one exists, is not specially diagnostic; it is often a hard swelling or a mere fulness, the borders of which are rounded and ill-defined, and inclined away from the surface; on percussion it gives a note of a doubtful kind—sometimes dull, sometimes half tympanitic and half dull—and if there is a communication between it and the stomach or bowel, a peculiar gurgling sound may be detected in it. It must further be borne in mind, whilst examining a doubtful case of abdominal disease or

¹ Rev. de Médecine, Nov. 1882.

tumor, that the liver, spleen, or other organ, may be displaced by the pus of a circumscribed abscess.

The *prognosis* is unfavorable in most cases, and unless early relief be afforded by aspirating or opening the abscess, or by its spontaneous rupture into the stomach or intestine. When the abscess is caused by tubercular peritonitis, or by malignant disease of the ovary, uterus, or bladder, there can be no prospect of recovery, and the abscess must be regarded as a mere accident in the course of the original disease. In sub-diaphragmatic abscess, if early exit be not given to the pus, there is great risk of the diaphragm being perforated, and of those secondary changes occurring in the thorax which tend so rapidly and surely to a fatal issue. Death occurs in some peritoneal abscesses suddenly, from rupture into the general peritoneal cavity; in others, after a fortnight or three weeks, from the intensity of the inflammation; and in others, again, after a tedious illness of twelve months or more, from pyæmia, hectic, or exhaustion.

Treatment.—This follows on the same lines as the treatment of other abdominal inflammations, until pus is suspected or detected, when it should be searched for, and evacuated by the aspirator or trocar. Where a tumor presents itself, or if the hypochondrium is bulged, an incision should take the place of tapping, and the edges of the opening should be kept apart by a drainage tube. Care must, of course, be taken to avoid wounding any of the viscera limiting the abscess space. In an interesting case, reported by Dr. Frederick Taylor,¹ of sub-diaphragmatic abscess, attended with effusion into the pleura, the trocar was employed; but it was found after death that the instrument had passed below the pleuritic effusion, into the lower lobe of the right lung—which was adherent to the diaphragm—but not low enough to reach the abscess. In other cases an abscess between the diaphragm and liver has been reached through the wedge-shaped, lower edge of the right lung—the lung having become adherent to the parts around; and as a sinus, limited by inflammatory material, has subsequently formed, the abscess has discharged itself through the lung without communicating with the pleural cavity, or further implicating lung tissue. This, however, is a condition which cannot be reckoned upon, though it is well known to occur occasionally. In cases where the abscess has pushed the diaphragm and lung far up, the pus may be evacuated by an incision in the seventh or eighth intercostal space, without injuring the lung or opening the general cavity of the pleura. Small hope of good accruing from puncture can be entertained if the abscess have already burst through the diaphragm, into either lung or pleural cavity, and death must be all but inevitable if it have burst into the general cavity of the peritoneum. The *vis medicatrix naturæ* is only too frequently the motto of the fool's paradise, and, as far as the patient is concerned, another term for death. Nature does not select the bowel or the stomach more frequently, if as frequently, as some more dangerous channel through which to evacuate these abscesses; and, therefore, in all cases in which the cavity can be reached and drained, operative treatment is the best, and the sooner it is adopted the better. Sometimes a mistake in diagnosis has happily led to these abscesses being opened, and the patients' lives being thus saved. A good case is reported in the Glasgow Medical Journal for April, 1876:—

A woman, aged 58, supposed to be suffering from ovarian disease requiring ovariectomy, was operated upon by Dr. E. Watson. On cutting through the abdominal parietes in the median line, about six quarts of thick pus escaped, and the finger passed into a cavity, in the lower part of which the organs of the pelvis were felt covered with

¹ Case of Abscess between the Diaphragm and Liver. Guy's Hosp. Reports, third series, vol. xix. p. 257.

flocculent lymph, while above, the wall of the abscess formed a complete partition between its cavity and the intestines. No foreign substance was found in the pus. A drainage-tube was kept in the abscess for a time. The patient made a good recovery.

2. *Diffused Abscess of the Peritoneum.*—As distinct from the circumscribed peritoneal abscesses just described, though sometimes associated with them, there is a form of suppurative peritonitis in which the whole of the peritoneum is involved, and in which, therefore, the abscess-cavity and the peritoneal cavity are one and the same.

Causes.—The cause of the suppuration is generally obscure, and certainly by no means always due to tubercular disease of the peritoneum. It has been known to follow typhoid and recurrent fever, chicken-pox, and exposure to damp and cold; and, again, it has come on without any known cause. It has sometimes been associated with suppurating mesenteric lymphatic glands; and in a case of suppurative peritonitis, in a man aged 31, upon whom I performed laparotomy in the middle line, I believe this to have been the cause of the disease. It is probable that the immediate cause of this form of exudative peritonitis is frequently a thrombus.

Symptoms.—After a period of perhaps severe but ill-defined illness, with symptoms suggestive of some abdominal disease, the abdomen will become irregularly swollen, of peculiar shape, and bulging prominently in the umbilical, hypogastric, or epigastric region, or on one side of the middle line, and towards the lumbar or iliac region. There will be dulness on percussion and tenderness on pressure, and subsequently a thrill will be detected in the prominent part. The temperature will vary, and will be generally found to rise to 101–103° F. in the afternoon or evening. Possibly the symptoms will have been ushered in with shivering and vomiting. There may then be the appearance of an abscess forming in the abdominal parietes, which may burst spontaneously; or, what is more likely, fluid will be suspected, an aspirating needle will be introduced, and some, and possibly very fetid, pus will escape.

If the pus is spontaneously discharged, it will most likely be at the umbilicus, and a fistulous opening will be left, through which a probe can be introduced into the general cavity of the peritoneum, and can be moved freely in every direction.

Course and Prognosis.—The chief danger in these cases is probably the liability of some of the pus becoming encysted between the diaphragm and liver, or diaphragm and spleen, and then taking the course of sub-diaphragmatic abscess—namely, perforating the diaphragm, and leading to death from empyema or suppuration in the lung. Or the pus may become encysted, and subsequently break into the bladder or rectum, and cause death by hectic or exhaustion; or a number of encysted collections of pus may be formed, separate and distinct from one another.

Dr. Goodhart,¹ to whom I am indebted for the narrative of three typical cases of diffused peritoneal abscess in children, had two recoveries and one death. One of the patients who recovered, was a girl, aged eleven, in whom an abscess burst at the umbilicus, eight weeks after she had fallen ill with typhoid fever. A sinus remained, and a copious purulent discharge continued for some months. There was a puffy fulness between the epigastrium and umbilicus, and great distension of the veins of the abdominal wall, but no fever whatever. Pus could be made to flow from the sinus by pressure upon every accessible part of the belly, and a probe passed inwards five or six inches, and moved freely in all directions. The other successful case was in a girl, aged five, whose illness had begun six weeks before with “inflam-

¹ These cases have since been brought before the Clinical Society of London. See *Lancet* and *Brit. Med. Journal*, October 20, 1883.

mation of the bowels." She was sent into hospital for supposed retention of urine; the abdomen was bulged "like the abdomen of pregnancy in miniature." An exploratory syringe, introduced two inches below the umbilicus, withdrew some thick, dirty-looking and fetid pus; two days afterwards a free incision was made antiseptically in the median line, and ten ounces of pus and very fetid gas were let out. A drainage-tube was retained for a few days; in a short time the discharge ceased; and by the end of six weeks the wound had quite healed. The third and only fatal case occurred in a boy, aged eleven; the pus was evacuated at the end of a month through a very small incision, which was afterwards enlarged, but death from double empyema and cheesy pneumonia followed three and a half months from the onset of his illness. At the post-mortem examination there was found general suppurative peritonitis; the coils of intestine were matted together, and there were three localized abscesses in the peritoneum: one led from the brim of the pelvis downwards between the rectum and bladder, into the ischio-rectal fossa; another lay between the liver and diaphragm, and had during life been opened through the latter by an incision in the eighth right costal interspace; and the third was between the spleen and diaphragm, and opened into the left pleura and lung. Such cases as the above are by no means peculiar to children, but occur in adults with perhaps equal frequency.

The treatment consists, in the early stage, in allaying abdominal pain and tenderness by opium and hot fomentations, and in keeping up the strength of the patient by mild nutritive food, such as milk, light puddings, beef-tea, etc.

As soon as the presence of pus is ascertained, a free incision should be cautiously made into the abdomen along the median line, unless there is any indication for selecting some other part, such as marked fluctuation or prominence. A drainage-tube should be left in the wound, and if pus is found to bag in places, it should be removed at the time of operation by means of well-prepared carbolized sponges. Indeed the "toilette" of the peritoneum should be carefully attended to in these as in all other cases, but officious interference with adherent purulent lymph must be avoided, as likely to lead to troublesome capillary bleeding. Schmidt performed laparotomy for purulent peritonitis, on a patient aged twenty-one, in the Moscow Military Hospital, and with a good result. The abdomen was opened by an incision from the umbilicus to the symphysis, and on division of the thickened peritoneum a large quantity of healthy pus gushed out. Drainage-tubes were inserted, and the wound healed, recovery being complete in two months.¹

VISCERAL ABSCESES.—I. HEPATIC ABSCESS.—*Causes and Mode of Origin.*—Amongst the most important causes of liver-abscess, as far as the surgeon is concerned, are surgical operations and other injuries.

A contusion of the substance, unattended by laceration of the capsule of the gland, is a recoverable injury, but one prone to be followed by abscess.² Ruptures and penetrating wounds of the liver, if not fatal from hemorrhage, may excite abscess. A case in which a sabre-wound of the liver was followed by an abscess of that organ, with ultimate recovery, is recorded by Dr. Otis;³ and Dr. Harley has published a case of recovery from hepatic abscess caused by a fall from a horse.⁴ Dr. Maclean mentions a fatal case of hepatic abscess

¹ Lond. Med. Record, June, 1882.

² Dupuytren, *Leçons Orales de Clinique Chirurgicale*, t. vi. p. 443; Lidell, *Am. Journ. Med. Sciences*, n. s. vol. liii. p. 340; Pollock, *Article on Injuries of the Abdomen in Holmes's System of Surgery*.

³ *Medical and Surgical History of the War of the Rebellion*, Part II., Surg. Vol., p. 129.

⁴ *Trans. Clin. Society*, vol. iv. p. 13. 1871.

following a blow.¹ It has been supposed that fracture of the skull, from falling on the head, is especially liable to be followed by abscess of the liver; but the fact that falls from a height are prone to produce laceration or contusion of this, the heaviest and largest of the abdominal viscera,² probably furnishes an explanation of the association, if it exists. It is, however, very doubtful if hepatic abscess and cranial fracture are frequently found in the same person.³

Budd and Frerich may be referred to for instances of hepatic abscess following operations for hemorrhoids and fistula in ano, the cauterization of cancer of the rectum, and violence in reducing rectal prolapsus. I have twice seen a large abscess in the liver after lithotomy: both men were about the same age—between sixty and sixty-five years—both came from the same village in Sussex, both died on the same (fifteenth) day after the operation. In each there was a large, single abscess in the liver; and in one suppuration had extended along the pelvic cellular tissue and the inguinal canal, and had led to an abscess in the course of the spermatic cord which had been opened during life.

Abscesses from such causes follow phlebitis, and are due to the transference of septic matters from the seat of operation to the liver, where they give rise, first of all, to embolic foci, the starting-points of the abscess. They are anatomically explained by the communication of the veins of the rectum, prostate gland, etc., with the portal system, through the inferior mesenteric vein. Hepatic abscesses occur after amputations and compound fractures of the lower limbs; any suppurating surface or cavity, more especially if in connection with diseased bone, and any ulcer, may give rise to them; but in these cases the general circulation, not the portal system, is the channel of infection, and the liver is invaded through the hepatic artery. These are the typical pyæmic abscesses, varying in size from that of a millet-seed to that of an orange, and they are often associated with similar abscesses in other viscera. (See Plate II., Vol. I., page 210, *supra*.)

The Netley Museum contains a specimen of liver-abscess the size of a walnut, in which a discolored needle, swallowed two years before, was found. The abscess had drained away through an opening into the duodenum; the man died of phthisis. Other foreign bodies, such as lumbrici, have been known to cause hepatic abscess. In the Netley collection is a liver showing numerous small abscesses surrounding lumbrici, which had perforated the organ in all directions, after reaching it by travelling along the biliary ducts from the intestine. Again, hydatid cysts and other new growths in the liver give rise to suppuration around them, and then to secondary hepatic abscesses within the area of the hepatic veins.⁴ Various ulcerated conditions of the stomach and bowels, but especially of the large bowel, are the cause of hepatic abscess: a case was in the Middlesex Hospital, in 1877, under care of Dr. Cayley, in which there were three abscesses, the size of oranges, or larger—two in the right and one in the left lobe of the liver. One of those in the right lobe communicated with a large sloughing cavity in the base of the right lung, and had been opened during life. There were several ulcers in the rectum, from one to two inches above the anus, which were regarded as syphilitic. In another case, in the Middlesex Hospital, in 1878, under care of Dr. Thompson, there were numerous ulcers in the colon, and sloughing of the appendix cæci. In each lobe of the liver there were several

¹ Reynolds's System of Medicine, vol. iii. p. 322.

² Richerand, Nosographie Chirurgicale, t. ii. p. 244.

³ Jones and Sieveking, Manual of Pathological Anatomy, edited by Payne, p. 620; also Ziemssen's Cyclopædia of Practical Medicine, vol. ix. p. 106.

⁴ Cornil and Ranvier, Manual of Pathological Histology, page 901.

abscesses the size of walnuts; each contained a little yellow pus and some necrotic liver-tissue of a sulphur-yellow color. Associated with, and doubtless caused by, the hepatic abscesses, was a large, circumscribed, peritoneal abscess in the right hypochondrium. It was bounded on the outer side, and above, by the ribs from the sixth to the twelfth inclusive, and by the diaphragm; on the left, or inner side, by the right lobe of the liver, the right border of which was concave instead of convex, and of a slate-blue color; and below by the colon, which was adherent to the liver and the abdominal parietes. Posteriorly, the abscess reached back as far as the angles of the ribs. There was a distance of a hand's breadth between the right edge of the liver and the thoracic wall. The colon, at its hepatic flexure, communicated with the abscess through an aperture large enough to admit the index finger. The abscess-cavity, which contained fetid gas and a dirty purulent fluid of a faint fecal odor, had been opened during life through a free incision in the sixth interspace. The lining membrane of the outer wall of the abscess was everywhere in a gangrenous condition. I might refer to other cases in which ulceration or sloughing of the cæcal appendix was found with abscess of the liver, and Dr. Goodhart tells me that his experience at the post-mortem room of Guy's Hospital leads him to regard disease of this appendix as a by no means unfrequent cause of hepatic abscess. Cases supporting this view have been recorded by Dr. Carrington.¹ The frequent association of hepatic abscess and dysenteric ulceration is well known, but their exact relationship is still a subject of dispute. There are good grounds, however, for believing in the occurrence of a form of hepatic abscess—the tropical abscess—due to suppurative inflammation of the liver and quite independent of dysentery, of every source of suppuration or ulceration, and of operation wound or other injury; and though it may coexist with or follow dysentery, it is but an effect, like the dysentery itself, of climacteric causes. Such is the opinion of Murchison, Sir J. Fayer,² and others; and such the writings and statistics of Waring, Morehead, Macpherson, Maclean, and others, go to prove. Budd and others have, however, thought differently, and Dr. Dickinson³ has recently pointed out some objections to this view.

Accepting the teaching of Murchison and Fayer, as to tropical abscess, we recognize three forms of hepatic suppuration: 1, The traumatic abscess; 2, The large, single, so called, tropical abscess, which, like the traumatic, is a local affection, though it may and often does coexist with dysentery; 3, The infective abscess; namely, that due to septic matter, whether derived from a dysenteric, syphilitic, or simple ulcer of the bowel, or from any other source within the patient, and whether the septic matter is conveyed to the liver through the portal veins, the hepatic artery, the hepatic veins, or the lymphatics.

Character and Size of Hepatic Abscesses.—Hepatic abscesses may be single or multiple, superficial or deep, encysted or quite undefined, with ragged and shreddy margins. The pus varies in quantity from a drachm or two to a gallon; and in color, consistence, and odor, it presents infinite varieties. It is frequently laudable, but may be greenish, brownish, reddish, or yellow, and sometimes it is mixed with sloughy shreds of liver-substance. A very good illustration of the large single abscess was seen in the case of a man, aged 35, with bronzed skin and hair like a mulatto, who was under Dr. Greenhow's care, in 1879:—

The lower ribs bulged, and dulness on percussion reached as high as the fourth rib in front. An incision through the seventh intercostal space was followed by the dis-

¹ Guy's Hosp. Reports, 3d ser., vol. xxvi.

² On Dysentery and Liver Abscess. *Lancet*, May 19, 1883.

³ *Trans. Path. Soc. Lond.*, vol. xxxii. p. 130. 1881.

charge of between 80 and 90 ounces of thick, dirty, brownish-green, but not offensive pus. On post-mortem examination, the lower lobe of the right lung was found adherent by recent lymph to the upper surface of the diaphragm. Fully three-quarters of the liver-substance was replaced by the abscess sac, which was bounded by liver-substance below and posteriorly, but above and in front, and also at the sides, by little else than the diaphragm and thickened liver-capsule. In front, the sac wall was particularly thin. After the evacuation of its fluid contents, the abscess-cavity still held some tenacious, solid masses, which adhered to the lining membrane, were greenish in color, and floated out in long shreds, like muco-pus, but were not of the nature of sloughs. There was great compensating enlargement of the left lobe of the liver; the spleen was enlarged and indurated, the kidneys were granular, and a quantity of ascitic fluid occupied the abdominal cavity.

Symptoms.—Liver-abscess is a disease of adult life, and is more especially common in tropical and malarial districts. Very extensive suppuration may be going on in the liver without giving any sign of its existence, either to the patient or to his medical attendant. The reason of this is, that the liver is not a sensitive organ, and that if the abscess is deep seated it may attain to serious dimensions before exciting peritoneal inflammation and pain. If the abscess is stoutly encysted, it may remain, perhaps, for years, and produce little or no constitutional disturbance. All writers with experience in tropical diseases, record cases in which persons, apparently in average health, have died suddenly from the bursting of an old and "silent" abscess. In malarial districts, and in Europeans debilitated from long residence in a tropical climate, the symptoms are obscure and insidious.

On the other hand, a small abscess near the surface will cause severe pain in the region of the liver, immediate elevation of temperature by two or three degrees, and a rise in frequency with increased sharpness of the pulse. If the abscess is situated near the upper surface, there will be a short, dry cough, often preceded, and for a while attended, by a friction-murmur at the base of the lung; whereas, if it be on the under surface, there will frequently be vomiting and other evidence of gastric or duodenal disturbance, or irritating diarrhœa, if the abscess is tending towards the colon, whilst if towards the outer aspect of the liver, there will be fulness, and perhaps fluctuation detected on careful manipulation. Non-encysted abscesses, even when deep-seated and of small size, are apt to excite fatal constitutional symptoms. In young persons not long resident in a hot climate, and especially if they have been living freely or intemperately, the constitutional symptoms are likely to be very severe.

The local symptoms are a sense of weight and fulness in the right hypochondrium, with inability to lie upon the right side; frequent spasmodic contraction of the rectus abdominis; and tenderness on pressure over the upper and right parts of the belly; occasionally fluctuation can be detected. The complexion is muddy and the countenance anxious; the tongue is thickly coated with a gray or yellow fur; and when suppuration commences, which in acute cases it does in from seven to twelve days, the patient emaciates, grows hectic, and has night-sweats. Rigors are of great significance when they occur, but are by no means constant; and both rigors and night-sweats are less marked in tropical than in infective abscesses. Slight jaundice often exists in the infective or pyæmic cases, and is due to the morbid condition of the blood from septic infection; but marked jaundice, excepting when the abscess arises from obstruction and ulceration of the bile-ducts, is very rare indeed. It seems to be an accepted dogma that when dysentery is complicated with hepatic abscess, ipecacuanha, so frequently prescribed for the dysentery, cannot be tolerated by the system.

Diagnosis.—A disease to some extent resembling, and often confounded with, abscess of the liver, is inflammation of the liver-capsule, known as perihepatitis. It occurs both idiopathically and secondarily, by extension of inflammation to the capsule in cases of hepatitis and hepatic abscess; and it is very important, owing to the requisite difference of treatment, to distinguish the idiopathic form from that which is a consequence of abscess. Idiopathic perihepatitis simulates pleurisy more than liver-abscess, and, unlike the secondary form, it is not preceded for many days by the symptoms of abscess—viz., loss of appetite, a feeling of malaise, with perhaps rigors and faintness, and some general fulness in the hepatic region. Moreover, acute perihepatitis is an illness of days, but one giving rise to sharp pain, febrile excitement, and local tenderness; whereas liver-abscess, though it is often attended by very ill-defined signs, is generally the cause of impaired general health, with a pale, muddy countenance, for a long time antecedent to the development of acute symptoms.

Hepatic abscess seems to have been confounded with distended gall-bladder, with cancer, and with hydatid cyst of the liver; but careful palpation and percussion, with due regard to the clinical history of the patient, ought to prevent these mistakes. It must be remembered, however, that hydatid cysts suppurate, and also give rise to suppuration around their walls. Pneumonia and pleurisy of the base of the lung will generally be distinguished by their physical signs on auscultation.

The *prognosis* is unfavorable, and especially so if the abscess be of septic origin. Complete recovery may, however, take place if the pus finds an exit, even though the discharge continue for many months. How much fatigue and exertion a person may endure when the subject of hepatic abscess, and yet recover, after endless journeying and deprivation, is shown by a very interesting case described by Sir J. Fayrer.¹ It is supposed that the pus is sometimes absorbed, but this is doubtful. An important element in the prognosis is the point at which the abscess is likely to burst; if rupture take place into the pericardium or peritoneum, death is certain; if into the pleural sac, the result is nearly always fatal; abscesses which point outwardly at an intercostal space are also unfavorable, but those which burst in the epigastrium are much less so. Morehead, Maclean, and Macpherson agree in this. Those which open into the stomach, intestine, or lung, are the most favorable. Dr. Harley² records a recovery from traumatic abscess, which he believes ruptured into the sac of the small omentum, and thence into the colon. Senac³ states that he has seen an abscess partially penetrate the diaphragm and then burrow beneath the pleura, without getting into the chest. Occasionally one and the same abscess opens by several apertures. If more than one abscess exists the prognosis is very unfavorable; this condition may be suspected if improvement does not take place after evacuation of an abscess. If from the position of the aperture the abscess can not empty itself, hectic, and then death, are only matters of time. The disease sometimes proves fatal even before the pus is evacuated.

Treatment.—When pus has once formed, bleeding, the administration of mercury, and other antiphlogistic measures which are so valuable in idiopathic perihepatitis, are worse than useless. The strength of the patient must be kept up by use of the mineral acids, tonics, nourishment, and wine. Hot fomentations to the abdomen give great relief, and so do leeches, when the general condition of the system does not contra-indicate their employment. Opium is generally requisite to ease pain, or at least uneasiness, and to procure sleep. As soon as fluctuation is detected, the aspirating syringe, adapted to a good-

¹ Lancet, May 19, 1883.

² Trans. Clin. Society, vol. iv.

³ Traité de la structure du Cœur, etc., tome ii. p. 307.

sized trocar and canula, should be used, and the canula should be left in for some days. Sir J. Fayrer has devised a grooved trocar and canula which is introduced in the ordinary way; if after withdrawing as much of the pus as will flow through the canula, it be thought desirable to make an incision into the abscess cavity, a long straight bistoury can be run along the groove of the canula, which thus serves as a director for the knife. In many cases it is preferable to open the abscess by a free incision, and this should be made if possible below the ribs, and as near the xiphoid cartilage as the case permits. A drainage-tube should be used. The evacuation of the pus gives relief to urgent symptoms, but the prospect of permanent recovery is not very great. In cases of true infective origin, only temporary benefit, if any, can possibly accrue, and as the abscesses are small and often multiple, there is generally no use in attempting surgical treatment.

In tropical abscess, change of climate often seems very beneficial, and a sea-voyage sometimes appears to work marvels. When a patient is suffering from a long-continued drain of pus, this resource should certainly be tried.

When fluctuation is not present, but the symptoms are urgent and the distress great, pus may be sought for with the aspirating needle.

With reference to the surgical treatment of hepatic abscess, hydatid cysts of the liver, and distended gall-bladder, much importance formerly was attached to the existence or non-existence of adhesions of the liver-cyst or gall-bladder to the abdominal wall prior to making an opening. Many surgeons considered it bad and dangerous practice to lay open these tumors until such adhesions had occurred, and various methods were employed with the view of securing their formation. An excellent and exhaustive account of these methods, and indeed of the whole subject of treating these collections of fluid, is to be found in Dr. Thomson's well-known work.¹ They may be briefly summarized as follows:—(1) Fixing the tumor by strips of adhesive plaster, applied over the abdomen before inserting even a fine trocar and canula. (2) Method of Graves, viz., to divide all the tissues to within a few lines of the peritoneum, and then stuff the wound with lint. The inflammation which follows is supposed to have the double advantage (*a*) of establishing adhesions, and (*b*) of determining the abscess towards this point. (3) Method of Bégin; an incision should be made down to the peritoneum, and this membrane should be raised with a pair of forceps and divided as if it were a hernial sac. If then it be found that the sac of the abscess, or cyst, be adherent to the parietes, it should be opened at once; if not adherent, by applying simple dressing to the wound for a few days, adhesions will take place, and the opening may be made as soon as adhesion is accomplished.² (4) Method of Récamier; this consisted in the application of caustic potassa to the skin over the swelling. The eschar which resulted was divided with a bistoury, and more caustic potassa was applied to the wound. This process was repeated until the caustic had caused firm adhesion of the two layers of the peritoneum, and then the abscess was opened with a trocar and bistoury.

The surgeons of to-day will, I think, endorse the conclusions expressed by Dr. Murray,³ who wrote in 1839: "I believe it is now the opinion of most, if not all, the queen's medical officers in this command, that the sooner an abscess in the liver is opened after its existence and site are ascertained, the better; and that there is neither much danger of effusion of matter into the cavity of the peritoneum, even when no adhesion exists between the liver

¹ Practical Treatise on the Diseases of the Liver and Biliary Passages, pp. 226 *et seq.* Edinburgh, 1841.

² Journ. Hebdom., 1830.

³ Madras Quarterly Medical Journal, October, 1839.

and external parietes, nor of hemorrhage from cutting pretty deeply into the substance of the organ, unless the operator be so ignorant and rash as to plunge his trocar into the large vessels situated near to the backbone. Surely the earlier the abscess is punctured, the better the condition of the liver and of the patient's constitution to institute the desirable process of adhesive inflammation and cicatrization, and the less degree of collapse and recession of the viscus there is likely to be from the parts naturally in apposition to it."¹ Dr. Murray further was disposed to believe that puncturing the liver in hyperæmia, hypertrophy, or inflammatory enlargement, so that blood should be abstracted from it (as the natives of India do in cases of enlarged spleen) would not only be perfectly safe, but would be singularly advantageous. Dr. Murray opened many hepatic abscesses, where no adhesions existed between the liver and the parietes, and in a good many instances the patients recovered, and in none did any matter escape into the peritoneal cavity after the operation. The escape of matter seems to be prevented by the constant state of apposition of the viscera. (Thomson.) Baron Larrey thought very highly of the practice of opening hepatic abscesses, and speaks of having had from twelve to fifteen successful cases. Dr. James Clark, of Dominica, had eight successful cases out of thirteen.

Dr. Horner,² of Philadelphia, about the same time as Dr. Murray wrote, related a case of hepatic abscess in which tapping had been performed before adhesion to the side had occurred, in the following manner: "An incision was first made horizontally, in a line with the anterior end of the eighth rib on the right side, a little in front of its cartilage, and through the side of the abdomen, which brought the liver into view; the latter was seen to rise and fall with the diaphragm in respiration; moreover, a knife handle was introduced between the surface of the liver and of the contiguous parts of the abdomen, thus making clear the want of adhesion. In this dilemma, I determined to stitch the liver to the side, which was accompanied by a large crooked needle, armed with a ligature of kid-skin of bulk sufficient to fill up the hole made by the needle. One stitch was made in this way, parallel with the upper margin of the incision, at the distance of four lines from it, and another in the same manner below. The liver being thus fixed closely to the side, a trocar and canula were plunged into the abscess, and five gills of purulent matter were immediately discharged, to the great relief of the patient; the matter continued to flow during the night, so that three or four more gills were discharged. The operation being ended, a bandage was put around the abdomen, so as to keep its viscera as still as possible. The canula was left in for fifty-four hours, and then a piece of a flexible catheter was substituted, the abscess discharging all this time small quantities of pus and serum mixed." Adhesion took place and no peritonitis followed, but death from exhaustion occurred after some days.

The modern method of opening these abscesses, and cystic tumors, and distensions within the abdomen, is practically the same as Dr. Horner's, the only differences being in matters of detail, such as the character of the sutures, the exact lines of incision, and whether the fluid should be evacuated before or after the liver, or cyst-wall, is stitched to the abdominal parietes.

II. BILIARY ABSCESS.—The gall-bladder may be the seat of suppuration, or an abscess may form at any part of the cystic, hepatic, or common bile-duct. These abscesses are generally the result of obstruction to the free passage of bile from simple or cancerous stricture of the duct, from biliary calculi, or from cancer or some other growth pressing upon the ducts.

¹ See Thomson, *op. cit.*, p. 232.

² *Am. Journ. of Med. Sciences*, old series, vol. xiv. p. 87.

(1) *Suppuration of the gall-bladder* is a consequence of irritation and over-distension, such as occurs when the common bile-duct, or, still more frequently, when the cystic duct, is obstructed.

Symptoms.—Enlargement from suppuration is characterized by a more or less pear-shaped and elastic, sometimes even fluctuating, swelling, projecting below the edge of the liver and in the normal situation of the gall-bladder. It is painful, and tender to the touch, and is accompanied by febrile symptoms, and frequently by rigors and night-sweats. If the cause of the inflammation is an obstruction in the cystic duct, there will not be jaundice, and the motions will contain bile; but if due to obstruction in the common bile-duct, there will be jaundice, and the motions will not be mixed with bile.

Sometimes there is the previous history of biliary colic, and after the abscess has discharged spontaneously, calculi may be passed at longer or shorter intervals through the fistulous track—their passage being attended by severe dragging pain around the opening, as well as by headache and occasional attacks of nausea or actual vomiting. The course of a case of abscess of the gall-bladder is commonly as follows: A patient, most likely a woman, but occasionally a man,¹ of or beyond middle age, suffers from one or more attacks of biliary colic, attended or not by jaundice and vomiting. Some time, it may be many months, after one of these attacks, which has lasted perhaps two or three weeks, persistent and gradually increasing pain, accompanied by fever and other constitutional disturbance, though perhaps not by jaundice, will be experienced in the region of the liver.

After a time an enlargement will be noticed in the right hypochondrium, and as it increases it will give a sense of fluctuation, and will present other signs of deep-seated abscess. Rigors and night-sweatings will accompany this condition, and soon, if relief be not given by surgical means, the abscess will burst externally through the parietes, somewhere in the neighborhood of the umbilicus, or internally into the colon, duodenum, or peritoneum. If externally, pus of a laudable character, or tinged with bile, will escape; all the severe symptoms will cease; and the patient will gradually recover. A fistula will for a time continue to discharge bile or pus, or pus and bile, and biliary calculi may work their way out or be removed. The opening is generally to the right of and above the umbilicus, over the fundus or body of the gall-bladder, but it may be at or below the umbilicus, and even at a considerable distance from the region of the gall-bladder, in which case the fistula is very tortuous. Possibly a second fistula will form a few weeks after the first; the length of time that the fistula will remain open differs very much in different cases, and has been already referred to under the heading of Biliary Fistulæ.

Diagnosis.—Suppuration of the gall-bladder sometimes presents all the characters of an hepatic abscess, especially of the large, single, tropical abscess. Even in shape and situation the one often resembles the other, and when this is so, a correct diagnosis can only be made by inquiring into the history of the case, and the previous residences of the patient. Such a tumor in a person who has never lived in a tropical or malarial climate, would most probably be an abscess of the gall-bladder, not of the liver. In other instances there is an appreciable difference between hepatic abscess and distension of the gall-bladder, as the tumor of the hepatic abscess is not well defined, but merges into the surrounding parts, and is very variable in its situation; but the swelling of the distended gall-bladder is circumscribed and distinct, and is always situated below the false ribs. The circumference of the fluctuating

¹ Dr. Habershon records a typical case in a man (Guy's Hospital Reports, 3d Ser. vol. xvi. p. 420); Dr. Murchison gives a typical case in a woman (Clinical Lectures on Diseases of the Liver, p. 531).

part of an hepatic abscess is always hard and swelled, whereas a distended gall-bladder is not generally surrounded by any degree of hardness or swelling, and fluctuation is as manifest at the circumference as at the centre.

Other forms of enlargement of the gall-bladder, as from bile, mucus, gall-stones, or cancer, are usually to be distinguished from cystic abscess by the absence of febrile disturbance, and by the less acute course of the local as well as of the general symptoms. These enlargements will be referred to again hereafter.

Prognosis.—Pyæmia and secondary abscesses of the liver are the most serious consequences. The fistula which results from the bursting of the sac will remain open an indefinite time, but may close, and sometimes quickly, if the cause of obstruction have been a calculus which has been discharged with the pus, or soon after the abscess has opened.

Treatment.—Rest is most important (1) to facilitate and promote adhesion of the inflamed gall-bladder to the parietal peritoneum; and (2) to avoid peritonitis becoming general, or even extending beyond the coats of the gall-bladder and the part of the parietes with which it is in contact. Any sudden or forcible movement might cause rupture of the inflamed, softened, and often fattily degenerated walls of the gall-bladder. Opium, leeches, and hot fomentations will be requisite to relieve pain. Cooling salines, and a light, nutritious diet must be given. As soon as suppuration has occurred, and the distended gall-bladder presents an abdominal swelling, the aid of the surgeon should be sought, and either an incision should be made down to the tumor, or the abscess should be opened by means of *potassa fusa*, introduced into the wound after incising the skin, fascia, and part of the thickness of the muscular parietes. Opening the gall-bladder directly by an incision, is the better practice; and in doing this it is advisable, after exposing the surface of the cyst, to empty it of its fluid contents by an aspirator, before cutting through its coats. By means of two pairs of spring forceps the gall-bladder should be drawn up into the wound; and when flaccid, its wall should be incised with scissors or a scalpel; the aspirating canula being thus liberated and removed, it remains only to stitch the edges of the divided gall-bladder to the edges of the wound in the abdominal wall. As these abscesses are nearly always due to biliary calculi, there is no use in simply aspirating the tumor, and thereby leaving the cause of the suppuration behind, without providing an exit for fresh-formed pus; nor is there much hope that the fistula which results from spontaneous external opening will give room, or be direct enough in its course, for the escape of the calculi. Such may be the case, or the evacuation of the pent-up pus may so change the line or surroundings of the duct as to allow of the stone passing into the bowel, or the stone may ulcerate into the duodenum or colon. But these are contingencies which cannot be relied upon, and in the mean while delay may result in the rupture of the abscess into the peritoneum.

An incision properly planned and performed, not only provides for the immediate evacuation of the pus, but allows of the efficient drainage of the abscess-sac, and of the removal of any calculi which may be in the gall-bladder, or in the duct within reach from the wound, either at the time of the operation or subsequent to it.

(2) *Abscess in the Biliary Ducts.*—Calculi may give rise to abscess in the ducts at any point at which they become impacted, or excite inflammation. If the calculus does not escape or become encysted, suppuration and abscess will occur. Sometimes a calculus impacted in a duct excites an abscess in the adjacent liver-tissue, and after a time the calculus may pass from the duct into the abscess-cavity thus formed; or inflammatory adhesions may form between the inflamed duct and the neighboring structures, and the calculus then pass into a circumscribed peritoneal abscess; or it may ulcerate through

the coats of the stomach or some part of the bowel, most frequently the duodenum, and so give rise to an intestinal or gastric biliary fistula.

The very small concretions constituting "biliary gravel," which are formed in the radicles of the hepatic duct in the interior of the liver, may induce partial obstruction of bile and dilatation of the ducts—in some instances becoming inclosed in firm fibrous cysts, but in others causing ulceration of the ducts and multiple abscesses in the liver.

Symptoms.—The symptoms of these intra-hepatic duct-abscesses are very obscure. They do not cause jaundice, enlargement of the liver, or pain; but sometimes they give rise to a sense of weight about the liver, with colicky pains and occasional attacks of rigors, followed by heat and sweating as in ague.

The extra-hepatic duct-abscesses give rise to biliary colic, tenderness in the hepatic region, and vomiting or intestinal disturbance; and if the abscess be in the common duct, there will almost certainly be jaundice from biliary obstruction, and the liver will be swollen and tender.

Treatment must be directed to the alleviation of pain, the abatement of inflammatory symptoms, and the removal of the obstruction, if possible, by the use of non-depressing emetics. It will be seldom, if ever, that surgical treatment will either be indicated or advisable.

III. ABSCESS OF THE SPLEEN is rare. It results occasionally from primary inflammation of the spleen, and is thus sometimes a consequence of injury, whether contusion or rupture. More frequently, however, it arises from inflammation secondary to some form of blood-poisoning, and it is then generally of embolic origin, the abscess being indeed a suppurating infarction; such are the cases which are caused by ulcerative endocarditis, wounds, surgical operations, and other exciting causes of pyæmia.

In other cases, splenic abscess is the result of phlebitis of the branches of the splenic vein. Diffused splenic suppuration is occasionally seen as a sequel of fevers. Suppurating hydatid cysts also lead to encysted abscesses, and sometimes to suppuration in the splenic tissue around the cysts. The spleen is sometimes involved in suppuration by extension of peritoneal abscesses, especially of those which are circumscribed, and which occupy the left hypochondrium.

Mr. Holmes¹ states that abscess of the spleen occurred in only one of six cases of pyæmia from necrosis of the tibia. In each of the six cases there was abscess of the kidney. Suppurating infarctions are generally well defined, and occur near the periphery of the organ; they are wedge-shaped, with the base towards the surface and the apex towards the interior; they vary in size from that of a pea to that of a hen's egg, or even much larger; and there are often two, four, six, or more foci present in the same spleen. If the separate abscesses break into each other, they may form one large cavity, containing pus and fragments of gangrenous or necrotic tissue, and occupying one-third or one-half the spleen; or even the whole spleen may be destroyed.

Results.—Splenic abscesses discharge (1) into the stomach or colon, (2) into the left pleural cavity, (3) into the peritoneum. In the latter event it may be the general cavity of the peritoneum into which the abscess opens, but what is perhaps more frequent is for the pus to become inclosed by inflammatory, fibrinous adhesions between the diaphragm and anterior parietes on the one side, and the stomach, colon, and small omentum on the other.

Symptoms.—The symptoms are in the first place those of inflammation of the spleen. Besides the general and constitutional signs, there are usually

¹ Trans. Path. Soc. Lond., vol. xiii. p. 188.

swelling, with tenderness and pain in the left side, and at a later stage possibly ascites or even general dropsy. Splenitis may however go on to suppuration without giving rise to any definite local symptom. In the later stages there may be hemorrhage from the intestine or stomach, as in other splenic affections.¹

The *diagnosis* must be made from lardaceous disease and from Hodgkin's disease of the spleen, from malignant disease of the stomach and pancreas, from renal, supra-renal, omental, and left-side hepatic disease,² and from ovarian tumor. When the sharp anterior edge of the spleen, and especially when the notches in this edge, can be felt, any abdominal enlargement springing from the left hypochondriac and lumbar regions, and below, will point to splenic enlargement, even though it extend beyond the linea alba on the right, and down to the pelvis. If the enlargement of the spleen have been preceded by pain and fever, and have been subsequently attended by rigors, night-sweats, and fluctuation, the presence of abscess may with some confidence be predicted.

Prognosis.—This is most unfavorable if the abscess arises from any infective cause. If the result of injury, recovery may follow the opening and drainage of the cavity.

The *treatment* of abscess of the spleen resembles that of abscess of the liver. When possible, the abscess should be laid open by an incision through the abdominal wall, and the cavity drained. This procedure should be conducted in the way that has been already described at page 605. When the abscess is situated near to, or reaches as far as, the surface of the spleen, the symptoms will with more certainty point to the nature of the disease, and operative treatment, unless the abscess be due to septic infection, will be more hopeful.

When the abscess is in the centre of the spleen, the symptoms may be quite insufficient to arouse the faintest suspicion of its presence, as in the case of the gentleman described by Dr. Abercrombie; and in these cases operative measures would be complicated by uncertainty as to the situation, and even as to the presence of pus. If, however, a deep-seated abscess be detected, it should be emptied by a trocar and canula, after exposing the spleen through an abdominal opening; and the canula should be retained, or its place taken by a full-sized tube, such as a catheter, passed through the canula before its withdrawal.

IV. ABSCESS OF THE PANCREAS.—Inflammation of the pancreas is not common, and abscess is but rarely met with. Various authors have however recorded cases. In some, only a portion, in others the whole of the gland-tissue has been found destroyed, and in the latter case the gland-capsule has become a mere membranous bag filled with pus. Portal saw two pounds of pus escape from such a sac. In some instances unchanged pancreatic tissue has been found floating in pus. Sometimes the pus is mixed with pancreatic juice, and is a clear, inodorous, yellowish fluid containing small curds. Sometimes it is grayish-white or greenish, and of a faint, mawkish smell. Occasionally it is very fetid. The capsule partakes in the inflammation, and becomes a good deal thickened. Or the suppurative process may involve the pancreas by invasion from without, and be but part of a circumscribed peritoneal abscess. The suppurative process commences in the interlobular cellular tissue, and a number of small punctiform abscesses form, which may increase and gradually coalesce.

¹ Aitken, *Practice of Medicine*, vol. ii.

² See Dr. Habershon's case in *Guy's Hospital Reports*, 3d ser., vol. xviii. p. 383. The diagnosis of this case was obscure, and it was doubtful whether the abscess was in the kidney or in the spleen, or in the left lobe of the liver.

Causes.—Metastatic abscess of the pancreas has been recorded as following disease of the testicle, suppuration of the spermatic cord, and castration. Portal and Petit give examples of this, and Petit uses them as arguments against the application of the ligature in extirpation of the testicle. In such cases the immediate cause of the abscess is thrombosis. Pancreatic abscess has also been observed in puerperal peritonitis, and in the bodies of those who have died of ague. Wilks and Moxon speak of having met with suppuration of the pancreas in the later stages of typhoid fever, pus forming around the gland as well as within it, just in the same way as the salivary glands are affected after fevers.

A calculus impacted in the pancreatic duct may excite suppuration within the gland. Fournier has recorded the case of an enormous abscess in the head of the pancreas, filled with calculi and giving rise to a localized epigastric swelling. Dr. G. Woodruff Johnston,¹ in an elaborate paper on "Calculous Affections of the Pancreatic Ducts," refers to two other cases of suppuration from the presence of calculi, in one of which an abscess the size of a nut, in the centre of the gland, contained several calculi, and had discharged part of its contents into the stomach through a hole as large as the thumb.

The pancreas may also share in the suppuration of some neighboring part; a perforating ulcer of the stomach or duodenum, for example, may be the starting point of the disease in the pancreas; or a biliary calculus or some other morbid condition may give rise to a circumscribed peritoneal abscess, in which the pancreas subsequently becomes involved.

Symptoms.—These are sickness, vomiting of a clear greenish fluid, thirst, faintness, constipation, and epigastric distension accompanied by general feverishness, and afterwards, in all probability, by rigors and sweating. If the collection of pus be large, it may produce symptoms due to pressure on adjacent organs. If ulceration of the capsule occurs, the pus escapes into the stomach, duodenum, or other part of the intestine, or into the peritoneum; and pus will then be discharged through the mouth or anus, or fatal collapse will occur. Abscess of the pancreas has been known to cause, by its pressure, obliteration of the gall-ducts and of the pancreatic duct, and, as a result, pale and fatty stools have been voided; and the pancreatic vein or the pancreaticoduodenal artery² may possibly be destroyed by it, and then syncope and pallor of the surface, with the other evidences of internal hemorrhage, may be witnessed. Obscure symptoms of peritonitis may alone exist.

Abscess of the pancreas does perhaps occasionally dry up, and a white, amorphous mass is the only remains of the pus to be seen. Even when they run their course, these abscesses are but rarely if ever *diagnosed*, and if they be diagnosed, surgical *treatment* does not seem to offer any prospect of relief or cure. Measures directed to the relief of urgent symptoms alone appear to be available. If a localized swelling follow the symptoms of inflammation of the pancreas, the propriety of an abdominal exploration, followed up by the opening and drainage of the abscess, ought to be seriously considered.

V. ABSCESS IN THE OMENTUM AND MESENTERY.—An abscess sometimes forms within the substance of the mesentery, or within either the small or large omentum, as part of a general suppurative peritonitis, or in association with a circumscribed peritoneal abscess. Again, pus sometimes burrows or bursts into the sac of the omentum from a neighboring part or organ.

In the History of the War of the Rebellion,³ mention is made of a shell-contusion of the abdomen, which was followed by sloughing of the abdominal walls and general

¹ Amer. Journ. Med. Sciences, Oct. 1883, p. 421.

² See case by Dr. Norman Moore, Trans. Path. Soc. Lond., vol. xxxiii. p. 189.

³ Op. cit., Part II., Surg. Vol., p. 24.

suppurative peritonitis ; at the post-mortem examination the mesentery was found enormously thickened, its glands inflamed, and in it were large collections of black, fetid pus, which communicated with the sac of the peritoneum.

Dr. Habershon¹ records a case of abscess of the lesser omentum lined by pyogenic membrane. The foramen of Winslow was closed, and the abscess-cavity was filled with brown, fetid contents. The omental abscess communicated with an abscess of the spleen through an opening about one inch in diameter at the posterior part of that organ. A hydatid tumor of the spleen had suppurated, and in addition to the abscesses of the spleen and omentum, it had led to the formation of a circumscribed peritoneal abscess.

A woman who was under my care in the Middlesex Hospital, with cancer of the uterus which had ulcerated into the bladder, died of very acute peritonitis. The cavity of the lesser omentum was distended with a thick, opaque, grayish fluid of purulent character.

Dr. J. Harley² relates a case in which he believes that an abscess of the left lobe of the liver burst into the omental sac, and then burrowed behind the peritoneum until it opened into the sigmoid flexure.

Mercklin described a case of abscess of the mesentery opposite a point in the right lumbar region which during life had been the seat of intense pain. In this abscess there were several calculi similar to one found in the pancreas itself ; the inference is that the calculi in the mesentery had escaped by ulceration from the pancreas, and had given rise to the abscess in the mesentery.³

Symptoms.—The symptoms of mesenteric and omental abscess will be probably quite indistinguishable from those of severe peritonitis running on to circumscribed peritoneal abscess. Fever, restlessness, thirst, nausea, and abdominal pain and distension have been very marked in some cases, and syncope and other evidences of diaphragmatic and cardiac disturbances have been recorded in others.

Treatment.—In most cases the treatment can be only palliative and expectant, but when the signs of peritonitis are present, the ordinary treatment for that affection must be employed. As these abscesses are for the most part secondary, and due to the bursting of an abscess in a neighboring organ, or to the irritation of biliary or pancreatic calculi, or are the result of a general suppurative peritonitis, little permanent good can be expected from laparotomy and the evacuation of the pus. The procedure would, however, be worthy of trial in any case in which from the symptoms all hope was not utterly abandoned.

VI. PERINEPHRIC ABSCESS.—Either acute or chronic inflammation of the cellulo-adipose tissue about the kidney is very likely to end in suppuration.

Causes.—The various injuries to which this part of the body is liable, such as blows, strains, punctured and incised wounds, whether they involve the kidney or not, and whether urine is extravasated or not, are likely to excite perinephric abscess. Sometimes the exciting cause is a chill, especially after exposure to great heat, and after sweating ; it occurs during the course of, or as a sequel to, the continued fevers ; and it is often the consequence of extension of inflammation from other parts, namely, the pelvis, colon, testicle and spermatic cord, spleen, liver, gall-bladder, or vertebre. It most frequently originates in suppurative pyelitis or nephritis, by extension through or actual perforation of the capsule—the kidney-affection in some cases being secondary

¹ Guy's Hosp. Reports, 3d series, vol. xviii. p. 383.

² Trans. Clinical Society, vol. iv. p. 13.

³ See Dr. G. Woodruff Johnston's paper, loc. cit.

to inflammation of the bladder, in others due to tubercle or calculus within the kidney. A renal calculus, after destroying to a greater or less extent the renal structures, may ulcerate through the capsule and lie loose in a suppurating space behind the kidney. Tuberculous matter may lead to ulceration of the capsule, and may sprout fungus-like into the tissue around the kidney; or perinephric abscess may be induced by it without its first perforating the renal capsule. Urethral stricture, vesical calculus, and disease of the prostate, may each lead to acute or chronic perinephritis. Evidence of chronic perinephritis is often seen in the post-mortem examination of such cases, and is furnished by the induration of the peri-renal cellular tissue and by the thickened and firmly fixed renal capsule which is left behind on attempting to remove the kidney. In acute cases, the capsule is found to be very vascular, and numerous abscesses are formed in the inflamed cellular tissue around the capsule. In time these abscesses coalesce, and burrow far and wide, if they do not soon open into the colon or at the loin. These abscesses may extend from the liver or spleen as low as the iliac fossa, and may at length protrude the abdominal walls, backwards, outwards, or towards the front. They occur commonly in adults, but as the result of injury they may arise at any age; though, perhaps, more frequent in men, they often are met with in women. Some few of these abscesses are quite simple in origin, course, and termination.

In the 26 instances brought together by Dr. Duffin, of King's College Hospital, London, 2 were the result of severe injury to the loin; 2 had a puerperal origin; 1 followed a renal abscess secondary to lithotripsy; 1 was excited by irritability of the bladder; 8 by kidney-disease; and in 12 the abscess appeared to have been independent of any affection of the urinary organs. In 5 of these 12 cases, a sprain of the loins seems to have been the exciting cause, in 3 exposure to cold, and in 1 the abscess was secondary to ulceration in the gall-bladder.

Symptoms.—The constitutional symptoms are the same as are excited by deep-seated abscesses in other regions, and will be more or less severe, according to the acuteness of the inflammation. Generally, they are well marked, but in old or weakly persons, and when the inflammation is chronic, they are masked, until the abscess by its size and pressure upon surrounding structures forces itself upon attention. A peculiar sort of lameness is often an early symptom, and is due to the flexed position in which the thigh of the affected side is retained in order to relieve pressure upon the inflamed structures. The sitting attitude is also, and for the same reason, characteristic; the person sits on one tuber ischii so as to relax the other side. Dr. Duffin, in an excellent summary of 26 collected cases,¹ draws particular attention to this lameness as a diagnostic sign, and points out its association with another tendency of these abscesses, namely, to implicate the pleura and lung. The mechanism of the lameness is explained by the pus following the track of the psoas;² and as the pus may follow this muscle downwards to the groin, so it may be guided by it beneath the ligamentum arcuatum to the pleural cavity. A case is recorded in which the pus took both directions; it ran along the psoas and between the pillars of the diaphragm, and also pointed in the groin.³

The local symptoms are a swelling or tumor in the region of the kidney, at first hard and resisting, and, if the parietes be thick and fat, indistinct and ill defined. It will best be detected by lifting, as it were, each flank in the fingers of one hand, and thus simultaneously comparing the resistance offered on the two sides. The affected side will often give the sense of in-

¹ Med. Times and Gazette, September 24, 1870, and November 16, 1872.

² See Dr. Dickinson's Case: Trans. Path. Soc. Lond., vol. xvi. p. 175.

³ Lancet, July 4, 1863.

creased resistance and weight, long before the abscess is large or prominent enough to give rise to any altered outline of the flank or abdomen. Deep-seated and often paroxysmal pain ushers in the disease; the pain may vanish for days or weeks, and then recur. A feeling of weight in the side is sometimes complained of by the patient, and I have seen œdema of the foot and ankle precede for many weeks the slightest sign of prominence in the loin. An inability to extend the thigh of the affected side has also in my experience occasionally been an early sign. The skin in the loin is often waxen and œdematous, unless the matter makes its way to the surface, and then it becomes congested. After a time, deep-seated fluctuation may be detected in place of the hard resistance previously felt; but this will depend much upon the thickness of the superjacent parietes. I have known as many as six pints of pus pent up, presumably for several weeks, in a perinephric abscess, and yet no fluctuation could be made out, owing to the enormous layer of subcutaneous fat. In this case an abscess in the testis of the same side for weeks preceded, and healed before the detection of, the perinephric abscess. The urine affords but a very imperfect guide, because, in the first place, it may have been long changed by antecedent vesical or renal disease, and because, in the second place, if the cause of the perinephric inflammation does not reside in the urinary organs, the urine itself may be quite normal; or at most there may be but a diminution in the quantity excreted, or it may contain some albumen as a result of pressure on the renal vein. When abscess follows injury to the kidney, the urine, which at first may have been blood-stained, may contain pus after suppuration has become established. The frequency of urinary complications, as seen from Dr. Duffin's list of 26 cases, was as follows: 2 patients had bloody urine; 6 had free pus in the urine; 2 had vesical irritation; 5 had renal disease without bladder signs; 12 were without urinary trouble of any sort. In the 2 cases in which blood was voided with the urine, the abscess was excited by severe injury to the loin.

The pus contained in these abscesses is sometimes odorless, in others fetid; and owing to the close proximity of the colon even a fecal odor may be present without a fistulous communication with the bowel existing. Sometimes lung symptoms on the affected side mask all others, and the case appears at first sight to be one of pneumonia.

Terminations.—The prognosis is always grave. The duration of the disease varies from two or three weeks to many months. If the abscess be opened, or burst externally, or in a favorable direction internally, recovery may ensue, unless the cause of the abscess be incurable. When serofulous disease of the kidney, or complete disorganization from impacted calculi, is the exciting cause, recovery may follow nephrectomy. If the abscess bursts into the lung, colon, or ureter, immediate relief from the general and local symptoms is experienced; and recovery may follow the discharge of pus in coughing, or by the bowel, or with the urine. On the other hand, it is possible, though fortunately not common, that fresh suppuration may be lighted up by extravasation of feces¹ or urine into the abscess, and a fatal termination arise from pyæmia, septicæmia, or gangrene of the lung.

If the abscess burst into the peritoneum, fatal peritonitis is the result; if into the pleural cavity, empyema will kill the patient. Death sometimes occurs from blood-poisoning, or from exhaustion; or it may be caused by the effects of pressure before the abscess has been opened, or has ruptured in any direction. Chest-complications are very common in these, as in sub-diaphragmatic peritoneal abscesses.

Compared with the frequency with which perinephric abscesses perforate

¹ See a typical case of this sort in the appendix to Dr. Bowditch's article on perinephritic abscess, in the First Med. and Surg. Report of the Boston City Hospital.

the pleura, the other forms of spontaneous opening are rare. Probably in 5 out of every 12 cases which pursue their own course, the abscess opens into the pleural sac or lung. Quain and Dickinson¹ each record a case in which it opened into the groin. Duffin gives 6 cases (out of 26) in which the abscess opened into the colon, 1 in which it opened into the peritoneum, and 1 in which it opened externally at the loin.

Diagnosis.—The history of the case, inquiry as to the probable or possible cause of the symptoms, the existence of some or all of the constitutional signs of suppuration, the lameness and position of the lower limb, the situation of the tumor, and the result of aspiration or of an exploratory incision in the loin, will serve to indicate the nature of the disease. Hydro-nephrosis and pyo-nephrosis, new growths of the kidney, spleen, or liver, enlargement of the mesenteric glands, and cancerous thickening of the ascending or descending colon, will in this way in all probability be excluded. The fever, the one-sidedness of the pain, and the attitude in standing or sitting, exclude lumbago. The absence of spinal deformity, and of other usual spinal symptoms exclude caries of the vertebræ. But the diagnosis is sometimes by no means simple.

Treatment.—In perinephritis, dry or wet cupping, early blistering, or the application of some other form of counter-irritation, may prevent suppuration. As soon as the presence of pus is suspected, it should be searched for with the aspirator, or by an exploratory incision in the loin. When matter is detected, it should be discharged through a free opening made like the incision in colotomy; the abscess-cavity should be washed out with a solution of iodine or carbolic solution, and a drainage-tube should be inserted. The loin should then be enveloped in a large hot fomentation of equal parts of water and carbolic-acid solution (1 in 40) applied on cotton-wool; or the carbolized gauze dressing may be applied. It is well to introduce the finger immediately after evacuating the abscess, so as to examine the condition of the kidney, and to detach any loose sloughs or remove any calculi which may be detected either within or outside the renal capsule. Absolute rest in bed should be enforced throughout. In 20 of the cases collected by Dr. Duffin² early puncture had been made—in 12 of these with complete success, and in 6 others “with a fair modicum of success.”

The patient's strength is to be maintained by nutritious food and tonics; and stimulants should be administered at such times and in such quantities as the case requires.

Even when no pus exists, if the signs of acute or subacute perinephritis are followed by pain, tenderness, and swelling in the loin, much benefit will accrue from the relief of tension by the nephrotomy incision; and the wound should be prevented from healing by the introduction of a drainage-tube. In one case which has come to my knowledge, pus followed after a while the healing of the incision, though none escaped at the time of the operation. All pain, however, ceased at once, and the wound quickly healed; but shortly afterwards the cicatrix opened up, and pus escaped from the deep parts of the incision-track. The patient is now quite well, and able to get about.

While writing these pages my attention has happily been directed to an able article, with a series of 10 cases, by Dr. H. I. Bowditch.³ In two of these cases early operations were performed, but no pus was observed at the time, and the operators considered that their operations had been in vain; but in both instances suppuration followed, and the tumors in the loin melted away.

¹ Trans. Path. Soc. Lond., vols. v. and xvi.

² Med. Times and Gaz., Nov. 16, 1872, p. 556.

³ Perinephritic Abscess, its Complications and its Treatment. First Medical and Surgical Report of the Boston City Hospital. 1870.

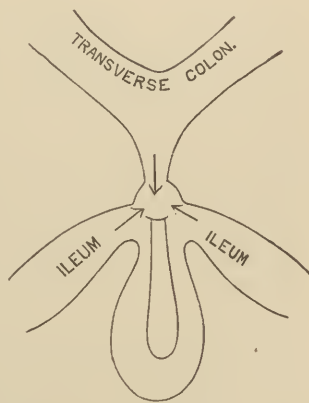
With Dr. Bowditch's conclusion as to early operation in these, and indeed in all abscesses about the peritoneal organs, I cordially agree, and I would strongly recommend the perusal of his article to all surgeons interested in the surgery of the abdomen. As he very rightly remarks: "If ever there be occasions for a *cautious boldness* on the part of the surgeon, these abscesses present them."¹

VII. FECAL ABSCESS.—Fecal abscesses are of two kinds, namely, (1) those which are caused by the extravasation of fecal matter, and which, therefore, are fecal from their origin, and (2) those which arise from causes quite unconnected with the bowel, but which at length ulcerate into it and become fecal by the destruction which they have themselves wrought upon the walls of the intestine.

It must be noticed, however, that an abscess, originally fecal, may communicate again with the bowel by opening into it from without, and after exciting ulceration or sloughing of the intestinal walls. These secondary openings are often at a part of the bowel a long way from the original disease. Again, on the other hand, a simple abscess or cyst may be converted into a fecal abscess, not by the extension or pressure of the original abscess or cyst, but by the destructive progress of some independent, but coexisting disease. A case in point has been recorded by Dr. Bristowe:² an ovarian cyst, the size of a walnut, was converted into a fecal abscess with thin, offensive, feculent contents, by the bursting into it of a fecal abscess in the cellular tissue about the rectum, which in its turn had been caused by the perforation of the rectum by ulceration commencing in its mucous membrane. Another fecal cavity, circumscribed by adhesions, had been formed in the same case and by the same process of ulceration in the colon; and this cavity had effected two secondary communications with two coils of the upper part of the ileum. (Fig. 1213.) These orifices, though close together, were, when measured along the course of the ileum, about a foot apart. This single case illustrates the two complications of fecal abscess just referred to.

Situations of Fecal Abscesses.—Fecal abscesses might be classified also according to their situation, into two sets, namely, the intra-peritoneal and the extra-peritoneal. Intra-peritoneal abscesses may be situated in any part of the abdominal or pelvic cavities: between the diaphragm and stomach, or colon; amongst the coils of small intestine; in the neighborhood of the cæcum or sigmoid flexure, in the right or left iliac fossa, or in the pelvis; and between the rectum and uterus, rectum and bladder, or uterus and bladder; they occur also in the hypogastric region between the pelvic organs below and

Fig. 1213.



Fecal abscess originating in disease of the colon, and communicating secondarily with the ileum at two places. (Bristowe.)

¹ Trousseau's Clinical Medicine (Sydenham Society's Translation), vol. v. pp. 333-365, should be consulted. An essay by Krætschmar, (*Des Abscès Périnéphriques*. Paris, 1872) may also be consulted. Dr. J. B. Roberts, of Philadelphia, has recently published a very valuable paper in the *Am. Journal of the Med. Sciences*, April, 1883, entitled "The Clinical History and Exact Localization of Perinephric Abscesses," which, besides its own intrinsic merit, is valuable on account of the references it gives to the works of others. So, for this reason also, is Dr. Duffin's article, of which I have made free use.

² Trans. Path. Soc. Lond., vol. xiv, p. 203.

the coils of intestine matted together and adherent to the parts around, above; and lastly, they are formed between the parietal peritoneum on the one side, and adherent omentum, small or large intestine, or stomach, on the other. In fact, there is no end to the variety in the mode of formation of these circumscribed, fecal, peritoneal abscesses.

Extra-peritoneal abscesses may be situated in the abdominal parietes on the front or sides of the abdomen, and may begin between or beneath the muscular strata of the abdomen; or they may be retro-peritoneal in position, as many of those are which arise from ulceration or sloughing of the vermiform appendix, as well as those which begin in simple suppuration of the retro-peritoneal cellular tissue about the kidney and elsewhere; in other cases they commence beneath the pelvic fascia in pelvic cellulitis, disease of the pelvic bones, or as the result of sloughing of the bowel in cases of reduction *en masse* of a femoral hernia: in other cases, again, they open at the scrotum or on the inner side of the thigh, on the buttocks, in the perineum, or at the back of the trunk. Psoas, iliac, and ilio-pelvic abscesses occasionally become fecal. Both intra-peritoneal and extra-peritoneal fecal abscesses may either be fecal in their origin or become fecal in their progress. Probably the extra-peritoneal are the commonest, both in the primary and secondary forms.

Causes.—The primary abscesses most frequently result from some obstruction in the bowels, giving rise to perforation by ulceration of the intestinal walls, above the seat of obstruction. Cancer of the stomach, small intestines, cæcum, colon, sigmoid flexure, and rectum; the pressure of some tumor outside the bowel, or of a foreign body within it; the ulceration caused by gall-stones; the various diseased states of the appendix cæci; and tubercular and simple ulcers of the bowel; and, lastly, injuries to the abdomen, are all known causes of primary fecal abscess, both within and without the peritoneal cavity. Cancer is probably the commonest of all causes, and the morbid product sometimes infiltrates the whole of the walls of the abscess.

A case was in the Middlesex Hospital, in 1881, under the care of Dr. Cayley, in which epitheliomatous ulceration of the sigmoid flexure had led to a fecal abscess, which contained about four ounces of black, fetid, feculent fluid. The tissues around the abscess were infiltrated with cancer, and the edges of the ulcer in the bowel were hard with cancerous deposit.

After cancer, disease of the appendix cæci is the next most common cause; and cases are very frequently met with in which, ulcerated, perforated, or sloughing, this appendage of the cæcum is found adherent to the back of the cæcum, and in connection with a fecal abscess in the right iliac fossa. In other cases the cæcal appendix, having descended along the inguinal canal in a hernial sac, to which it has become adherent, has given rise to one or more fecal abscesses in the scrotum.

Mr. Shaw, my much respected colleague at the Middlesex Hospital, has recorded¹ a very interesting and instructive case, in which a succession of abscesses resulting in fistulæ formed in a scrotal tumor of very obscure nature. The matter discharged at first was healthy pus, but soon it became sanious, very offensive, and afterwards was of a pale orange color, but never distinctly feculent. The quantity discharged was always profuse, but sometimes increased greatly without any corresponding change in the condition of the tumor. There was no pus in the stools, and no interference whatever with the action of the bowels. The patient died at the end of a year, exhausted, and then the case was found to be one of omental hernia; the omentum adherent to the sac enveloped the vermiform appendix, which was healthy all the way down to within half an inch of its blind extremity, where it was in great part destroyed by ulceration, and communicated with the sinuses in the scrotum. The patient was an old man who was supposed

¹ Trans. Path. Soc. Lond., vol i. p. 278.

to be suffering from disease of the right testicle, and when admitted under Mr. Shaw's care, in July, 1845, there was an irregular swelling of the scrotum with enlargement of the cord, but owing to the thickened condition of the skin and cellular tissue, the testis could not be felt. In a short time phlegmonous inflammation took place in different parts of the swelling, and the abscesses followed.

Another case, recorded in the same volume of the Pathological Transactions by Dr. Thurnam,¹ was that of a gentleman who had long worn a truss for "an incipient right inguinal hernia." Suddenly the swelling increased, and became very tender and painful, and an abscess formed in the upper part of the scrotum, which was opened, giving exit to a little olive-colored, very fetid purulent matter, and gas. A second abscess formed below the first, and was opened five weeks subsequently. At the end of two months, the sinus left from the last abscess was laid open, and a triangular piece of hard bone, with sharp angles, was discharged the same day. From this time the sinuses closed. Death occurred from other causes some time afterwards, and it was then found that the hernia consisted of an enlarged and thickened appendix cæci, the apex of which was opaque and contracted, and adherent to the hernial sac by a firm band of adventitious tissue.

A case of fecal abscess from the ulceration of a diverticulum of the ileum, which had become invaginated in the sac of a right inguinal hernia, in an old woman aged seventy-seven, is recorded by Dr. Dowse.² This specimen, which I had the opportunity of examining, was a diverticulum from the lower part of the ileum, and was adherent along its upper and forepart to the sac of a direct inguinal hernia. There was no evidence of its ever having been strangulated or constricted, and the perforation had no doubt arisen by ulceration, beginning on the mucous surface. The patient recovered from the abscess with a fistulous opening, but died three months afterwards from a severe attack of diarrhoea.

Herniæ of the vermiform appendix are, perhaps, less rare than is commonly supposed, and such cases as the above should make the surgeon be at once on the alert in doubtful or obscure inflammatory swellings of the scrotum or groin.

I have on three occasions seen the cæcal appendix, either alone or with omentum, or the cæcum, in a hernial sac; and in one case—that of a woman, aged sixty-seven—it was so changed in appearance that it was mistaken for a band of adhesion, and cut through with the omental sac which surrounded it. The proximal end of the appendix cæci, with the stump of the omentum to which it was attached, was tied with catgut ligature and left outside the ring; and it was only after the operation and on microscopic examination, that the real nature of the structure was made out. Strangulation had existed for five days before the operation, and the knuckle of bowel, the size of a small apple, which was contained within the omental sac, was everywhere quite black, and in two places quite sphacelated. The patient died within forty-eight hours of peritonitis, which had become general before the operation.

In cases of perforating ulceration on the front or side of the cæcum, a circumscribed, intra-peritoneal abscess will form, provided that adhesions exist before the perforation occurs; otherwise death from fecal effusion into the general peritoneal cavity will result. Such an abscess will, however, in all probability soon open upon the abdominal wall, in the iliac region; unless, as sometimes happens, it has a downward direction towards the pelvis.

Allied somewhat to the cases of fecal abscess resulting from sloughing or ulceration of an unreduced hernia, are the intra-peritoneal abscesses which follow complete reduction, and the extra-peritoneal abscesses which result from reduction *en masse*. If complete reduction has been effected, and adhesions have had time to form prior to the giving way of the coats of the bowel, an abscess, circumscribed within the peritoneum, will form; but in a

¹ Ibid., vol. i. p. 269.

² Ibid., vol. xxvi. p. 109.

short time, most likely, it will open externally through the operation wound, or in the neighborhood of Poupart's ligament, and a fecal fistula, leading out of the abscess-cavity, will result. When a hernia has been reduced *en masse*, extravasation will sooner or later (if the patient does not die of strangulation beforehand) take place into the areolar tissue outside the parietal or pelvic peritoneum, or between the pubis and pelvic fascia.

I have seen two such cases, though not in my own practice. In one, a woman aged forty had been operated upon for strangulated femoral hernia; a small bundle of bowel had completely sloughed away. Within a large fecal abscess-pouch, between the pubis and bladder, and beneath the pelvic fascia, there were two intestinal orifices, one leading into the portion of the bowel which entered, and the other into that which left the abscess-cavity; all communication with the peritoneal cavity was completely shut off by firm adhesions between the parietal peritoneum and the bowel, and there was no general peritonitis; the patient died of collapse. In the other case, a fecal abscess followed sloughing of a strangulated hernia in a pregnant woman. There was a large fecal abscess behind the pubis extending down to the neck of the bladder, and separating this viscus from the pubic symphysis. There was a sloughy opening into the ileum fifteen inches above the ileo-cæcal valve, large enough to admit a finger; and an opening on the surface a little above and to the left of the pubis, from which sinuses burrowed in the parietes, both outwards towards the iliac crest, and forwards and downwards behind the pubis, just above which there was also a second opening. There was no evidence of past or recent general peritonitis. I have seen a third case of, as I believe, exactly the same kind as the first of the above, but the condition was not verified by a post-mortem examination.

Cancer of the uterus, bladder, vagina, or rectum is a frequent cause of both intra-peritoneal and extra-peritoneal fecal abscess; these are generally discovered on the post-mortem table, but they sometimes present themselves as circumscribed swellings, roofed in by coils of small intestine matted together, and adherent to the parietes in the hypogastric region.

The pressure of a pelvic tumor, by causing obstruction in the bowels, may lead to a large fecal abscess in the pelvic cellular tissue, which may open upon the buttocks in more places than one. I had such a case for a long time under my care in the Middlesex Hospital. By degrees the rectum had become completely flattened by the pressure of multiple uterine fibroids, and when the patient came under my notice there was great abdominal distension, and nearly all the fecal matter which escaped passed through fistulous openings in the buttocks, which burrowed out at both great sciatic foramina. Colotomy was performed; the large abscess almost completely dried up; and the patient lived for two years after the operation in comparative comfort. Dr. Wilks has put on record a case of multilocular cyst of the left ovary the size of a new-born child's head, on the right side of which was a fecal abscess communicating with the cæcum; as no disease existed elsewhere, it is presumable that the abscess was caused by the irritation and inflammation set up by the tumor, but it is not actually said that such was the fact. The case is reported on account of the intra-cystic growths being covered by ciliated epithelium.¹

Gall-stones may lead to intra-peritoneal abscesses which may be fecal at their origin, or may become so. The following is a good example of an extra-peritoneal fecal abscess from gall-stone; as the patient recovered, it is impossible to say with what part of the bowel the fecal abscess communicated.

A healthy girl, aged ten, who had never ailed beyond occasional attacks of indigestion and bilious vomiting, suffered after one of these attacks pain extending from the right groin to the right back; there was much tenderness over the cæcum, and the belly was

¹ Ibid., vol. vii. p. 281.

tympanitic; within a fortnight an abscess had formed in the back, and was opened: it discharged at the time fetid, thin, brown pus, and gas; and four days afterward a hard round substance the size of a nutmeg escaped from the wound. The child made a quick recovery. The concretion consisted of a nucleus composed almost entirely of cholesterine surrounded with feces. The biliary origin of the nucleus was beyond doubt.¹

Occasionally a fecal abscess may be avoided, although the bowel is entirely perforated by the adhesion of some neighboring organ to the edges of the ulcer. A case of syphilitic stricture of the rectum was under the care of my colleague Mr. Lawson, in 1881. There was a great deal of ulceration above the stricture, and at one spot, six inches from the anus, a perforation the size of a sixpence existed; but no extravasation had occurred, as the left ovary formed the floor of the ulcer, though not absolutely adherent to its margin at all points.

The secondary fecal abscesses, those namely in which fecal extravasation takes place into an abscess already existing, may like the primary cases arise from many causes. These have been enumerated under the sections "Abscess of the Parietes" and "Circumscribed Peritoneal Abscess," "Retro-peritoneal Abscess," and "Ilio-pelvic Abscess." Did space permit, I might relate cases of each of these varieties of abscess which have at a later stage become fecal. I may however refer to the first case of fecal abscess ever recorded in the London Pathological Society's Transactions. It was published by Mr. Cæsar Hawkins.²

The case occurred in the person of a man, aged twenty-four, who fell from a height of twenty feet and ruptured his diaphragm. On the following day he complained of a fixed, defined pain on the left side, a little below the hypochondrium; this was accompanied by slight hæmatemesis and inability to take food. Till the ninth day he progressed favorably, but then he was seized with collapse, attacks of which occurred subsequently at intervals till about the tenth week, when he was seized with pain in the abdomen accompanied by constipation, and followed by diarrhœa, and by the passage of blood by stool. An acute attack of pleurisy set in, of which he died in the thirteenth week after admission. He was kept alive by enemata the whole of the time, as the inability to take food by the mouth continued throughout. At the post-mortem examination, a large cyst was found in the lower part of the abdomen among the convolutions of the intestines, containing pus and fecal matter, and communicating with the lower part of the colon. In the left pleural cavity were two distinct, circumscribed effusions, the one at the upper and the other at the lower part of the cavity, between the lung and the diaphragm. There was a laceration an inch across in the diaphragm, and through this the lower pleural abscess communicated with another in the abdomen, behind the stomach, and bounded likewise by the spleen and kidney; it contained about a half pint of pus. There was a further partial laceration of about six inches in length, in the part of the diaphragm forming the wall of this abscess.

In this case the seizure of abdominal pain, followed by diarrhœa and the passage of blood by stool, marks the time at which one of the circumscribed peritoneal abscesses opened into the colon, and in turn became fecal by the escape into it of some of the contents of the large bowel.

Symptoms.—Fecal abscesses are too diverse in their origin and course to allow of any description of symptoms applicable to all. Many of them have nothing in common; and this is what would be expected by those who bear in mind that the abscess itself, in primary cases, is but a complication of some pre-existing morbid condition; and that in the secondary class the fecal element is but an accident in the course of an abscess from whatever cause arising, just as in other persons, or under other conditions, the opening of an abscess

¹ Trans. Path. Soc. Lond., vol. xxviii. p. 130.

² Ibid., vol. i. p. 150.

into an artery, vein, or joint, is an accidental complication. It is, therefore, manifestly as absurd to regard fecal abscesses as a form of disease *sui generis*, as it would be to classify the others as "arterial abscesses," "venous abscesses," "articular abscesses," etc.

As all fecal abscesses come under one or other denomination—intra-peritoneal or extra-peritoneal—I must refer the reader to the accounts which have been given of the symptoms of the several kinds of abdominal abscess.

Three features may be mentioned, however, as specially characteristic of fecal abscesses, and though they are not always present, they very generally appear at some stage in the course of the disease. (1) Where fecal fluids and solids can reach, fecal gases can go also, and hence, with fluctuation, a degree of resonance or of emphysematous crepitation should be looked for. The pressure of gas in these abscesses is often evinced by the escape of bubbles, of fetid odor, as soon as an opening is made. When the abscess is sufficiently near the surface to be percussed, or to form a prominence or tumor, it will be found dull as long as no air has entered it; but if it become fecal by forming a communication with the bowel, air will very probably enter it and take the place of some of the pus which escapes into the bowel. (2) When after the ordinary symptoms of any abdominal phlegmon, pus is found in the stools; or a quantity of liquid, or putty-like, semi-liquid stools of a light color come away—which the patient may describe, as one of mine did,¹ as "coming away all cold;" or if diarrhœa with blood in the stools sets in, or a number of coagula are passed with the feces; under any of these circumstances the diagnosis is conclusive of an abscess in connection with the bowel. If after, or at the same time that any of these changes are seen in the stools, a pre-existing swelling, which was before dull, becomes tympanitic, the conclusion that an abscess has become fecal, is almost certainly correct. (3) When a fecal abscess reaches the subcutaneous cellular tissue in its course outwards, there are marked signs of diffused cellulitis of a more phlegmonous character, wider extent, and accompanied with more severe constitutional disturbance and depression than is seen in ordinary or non-fecal abscesses. The brawny hardness of the tissues is associated with marked tenderness and great pain, and an angry or livid red discoloration of the skin. As the abscess reaches the surface, diffused crepitation may be detected, and a soft boggy feeling is conveyed to the finger. Sometimes a large bleb is formed on the surface, or distinct patches of skin become gangrenous, and slough away, leaving a fistulous opening which discharges pus and fecal matter.

The symptoms of a fecal abscess may be the first indication, instead of one of the later ones, of some fatal disease.

This fact is illustrated by a case recorded by Dr. Thurman,² of extensive medullary cancer of the transverse colon, the first sign of which was an illness beginning with pain, fulness, and tenderness, in the right side of the abdomen. This attack subsided in a fortnight, and was followed in three weeks more by a circumscribed tumor, the size of an orange, just below the umbilicus. The tumor increased rapidly in size, and at the end of a week fluctuated, the fluctuation being combined with emphysematous crepitation. The swelling was opened, and gas and fetid feculent matter escaped, pus and coagula being mixed with the feces. Afterwards the abscess-walls sloughed, but subsequently all healed and closed entirely, though the scar re-opened. The patient died some months afterwards with extensive fungating cancer of the colon, sprouting into and filling the lumen of the gut; through the cancerous tissue there was a fistulous communication with the abscess. The abscess-cavity had been formed by the omentum, cæcum,

¹ Lancet, July 14, 1883, p. 53. Case of "Rupture of the Urinary Bladder."

² Trans. Path. Soc. Lond., vol. i. p. 265.

and transverse colon, firmly adherent to the abdominal parietes below the umbilicus, and to one another. A second communication between the bowel and the abscess had been formed at the cæcum.

Prognosis.—In the first class, or primary abscesses, the prognosis will depend chiefly upon the cause of the abscess; in the second class, or secondary abscesses, it is rendered less favorable by the abscess becoming fecal. As an instance of how rapidly a secondary fecal abscess even of great size may heal, the following case, under the care of Sir William (then Mr.) Lawrence, may be quoted:—

A woman, aged 22, fifteen days after a rigor and pain in the iliac and hypogastric regions, had an abscess opened in the left loin, and 70 ounces of fetid pus escaped. Three days afterwards, the bowels having previously been confined, 80 ounces of feces with some purulent matter came away through the incision, on the patient being moved in bed. In a few days the abscess healed, and the woman was discharged quite well. The reporter remarks: "The above is the only instance we remember in which some days after the opening of an abscess in the loin, the whole contents of the intestine came away through the wound, and then the opening in the gut closed completely and permanently, and the patient recovered entirely in three weeks."¹

When an abscess discharges into the stomach or bowel, the patient's recovery is often insured thereby; but if a mutual interchange of contents goes on, and fecal matter passes into the abscess, the gravity of the case is much increased, even though an external opening also exists. In either class of cases, there are the dangers (1) of blood-poisoning, (2) of exhaustion from prolonged and profuse discharges, and (3)—when the abscess results in an external fecal fistula, and the communication with the bowel is high up in the tube—of the emaciation and starvation which result from the escape of the intestinal contents. Another danger is lest the abscess burst into the general cavity of the peritoneum; or again, the pus may burrow, and in its course destroy, to a greater or less extent, such important organs as the pancreas, spleen, kidney, lung, etc. None of these dangers, however, except that of starvation due to the escape of intestinal contents, are peculiar to fecal abscesses.

Sometimes recovery takes place after the formation of long and sinuous tracks, and after the abscess has been opened in several places, or resulted in the partial destruction of some muscle, such as the psoas or iliacus. Sometimes death takes place very slowly, and long after the abscess has settled down into a mere fistulous opening; in other cases the resulting fistula closes and breaks again and again, or a fresh abscess is lighted up in its track. Sometimes a fecal abscess will attain a large size in an insidious and "silent" manner, and without warning suddenly burst into the peritoneum, and so quickly cause death. Mr. Pollock, in Holmes's *System of Surgery* (third edition), gives a good illustration of fecal abscess, connected with disease of the appendix cæci, taking this course; and did space permit, cases illustrating each of the above statements might be quoted, and some of those already given in the text might be referred to in corroboration of their truth.

Treatment.—The treatment of fecal abscesses in their early stages does not differ from that of other abscesses. As soon as there are signs of extravasation of fecal matter or suppuration, a free opening should be made. Disinfectants, irrigation, and constant change of dressings will be requisite; the bedding and the air of the room must be kept as fresh as possible; pain must be allayed by anodynes, and the strength maintained by tonics, good diet, and stimulants.

When the cause of the abscess, or of the resulting fistula, persists, it should

¹ British Med. Journ., August 22, 1857, p. 709.

be removed, if possible; when this cannot be done, operative measures may at least relieve the patient's suffering, prolong his life, or even close the abscess, as the case in which I performed colotomy illustrates. When the abscess is due to reduction *en masse*, the bowel should be freely exposed, the parts thoroughly cleansed and disinfected, and the ends of the bowel sewn together, after cutting away what remains of the gangrenous tissues. To attempt division of the stricture of the hernia under these circumstances, without uniting the ends of the sloughed bowel, would only be to invite a hasty death by opening up the general cavity of the peritoneum to the putrid contents of the fecal abscess. When the abscess has been caused by the cæcal appendix in a hernial sac, the treatment would be to remove the diseased portion of the appendix, and then to close by sutures the cut extremity, taking care to invaginate the walls so as not to bring two mucous surfaces into apposition by the stitches.

The abscesses situated in the iliac fossa, and arising from cæcal or pericæcal disease, or from disease about the sigmoid flexure, should be treated by an early external opening. It is too generally a question in these cases of giving the patient the chance of relief afforded by the operation, or of leaving him to die without one.¹

VIII. ILIO-PELVIC ABSCESS.—Ilio-pelvic abscess is to be distinguished from ilio-psoas abscess. The latter owes its origin generally to caries of the lumbar or lower dorsal vertebræ, but occasionally to disease of the sacro-iliac joint, to strain of the muscular fibres, or to burrowing of a perinephric abscess; the former has a variety of causes.

Ilio-pelvic abscesses are of two sorts, (1) the sub-peritoneal, and (2) the sub-aponeurotic. The *sub-peritoneal* are prone to spread widely in both an upward and a downward direction, reaching the kidney, or even burrowing behind the diaphragm, and running in the opposite direction amongst the pelvic organs. Such abscesses are rarely circumscribed, and if not opened by the surgeon, are prone to burst spontaneously at some point in the lower part of the belly, or even at the umbilicus. Cases of this character have been described and referred to in the section on Retro-peritoneal Suppuration (see page 548). Bérard gives a case in which the abscess, starting in the left iliac fossa, burrowed across the median line in the hypogastric region, and reached the right iliac fossa, ultimately discharging itself at the navel. The abscess followed labor; the patient died. An abscess reaching up to the left iliac fossa, and opening in the linea alba, may arise from a lithotomy incision:—I have known a case in which a sinus opened two inches above the symphysis pubis, and exuded a thick pus, from an abscess on the left side of the true pelvis. The sinus-track led downwards in the fascia transversalis, behind the rectus, as far as the left groin; here it descended vertically behind the longitudinal ramus of the pubis into a large abscess cavity; an off-shoot of the sinus, before dipping thus downwards, ran outwards for a short distance towards the anterior superior spine of the ilium, and there ended in a *cul-de-sac*. The lithotomy wound, which was very large and lined with phosphates, extended back to the level, and just to the left side, of the orifice of the ureter, but was shut off from the pelvic abscess referred to.

The *sub-aponeurotic* abscess forms between the fascia iliaca and the iliac muscle. For a time it is circumscribed, but if not evacuated, the pus burrows to the front of the thigh, which it reaches by passing beneath Poupert's ligament between the anterior superior spine of the ilium and the outer edge of the crural sheath. In some cases the hip-joint has been opened by

¹ See an article by Dr. Willard Parker. Med. Record, March 1, 1867.

the pus following the course of the ilio-psoas tendon and bursting through the thin part of the capsular ligament, at the spot where those muscles cross the articulation. I have amputated the limb at the hip-joint in a lad of seventeen, for necrosis of the acetabulum, which apparently had an iliac origin; suppuration within the pelvis had for a long time preceded hip-joint disease, and the abscess, after opening above Poupart's ligament, extended around the great sciatic notch to the back of the hip, and then into the hip-joint, which became completely disorganized. The case ended fatally, and the post-mortem examination disclosed extensive necrosis of the inner surface of the expanded wing of the ilium, and what remained of the iliacus muscle was quite black and softened. In other instances, the pus having burst through the iliac fascia, and extended below the brim of the true pelvis, has passed out through the great sacro-sciatic notch into the gluteal fossa, where it has burrowed beneath the gluteal muscles. I have opened such an abscess in more than one place in the buttock, as well as in the upper part of the thigh, pus being subsequently discharged into the bladder as well, and the flow being kept up in spite of free drainage. Suppuration may, I believe, extend from a diseased hip-joint by the same route into the pelvis, but it is then sub-peritoneal in character, not sub-aponeurotic. It is well known that hip-disease often extends through the floor of the acetabulum to the pelvis.

In 1881, a case was under the care of my colleague, Mr. Geo. Lawson, of sub-aponeurotic iliac abscess on both sides; it was not of vertebral or sacral origin, but the exact cause could not be made out at the autopsy. In this case of Mr. Lawson's, the abscess of one side did not communicate with that of the other. On the left side, the abscess had broken into the sheath of the psoas, and the pus had descended below Poupart's ligament; on the right side, the abscess had ulcerated through the sheath of the iliacus and opened above the crest of the ilium in two places—in the right groin, and over the right side of the middle sacral vertebra. The case shows that an iliac abscess may become an ilio-psoas abscess, and therefore that the latter may occur without any assignable cause such as caries of the vertebrae.

Ilio-pelvic abscesses have been known to evacuate themselves through the uterus and vagina, but much more frequently they are discharged through the rectum, sigmoid flexure, or bladder. Sometimes they have proved rapidly fatal by bursting into the general peritoneal cavity.

Occasionally the sub-aponeurotic abscesses result in the more or less complete destruction of the iliacus muscle and the periosteum of the iliac fossa, as in the case just referred to. The psoas and quadratus lumborum muscles sometimes share in the destruction. The iliac vessels and the anterior crural nerve, external cutaneous, obturator, and other branches of the lumbar plexus, as they pass across the pelvis are affected by contact with the pus, or suffer compression owing to the indurated and contracted condition of the inflamed tissues which surround them.

Causes.—Ilio-pelvic phlegmons are perhaps most commonly seen as sequelæ of labor, and it is supposed that they are most frequent among primiparæ. They occur, however, from several other causes, such as injury, periosteal and osteal inflammation, laceration of muscular fibre, and extravasation of blood. In one case, already referred to under the heading of Hepatic Abscess, suppuration was started in the pelvic cellular tissue by a lithotomy wound; the pus took the course of the spermatic cord, and burrowed along the inguinal canal to the scrotum, at the upper part of which it was evacuated through an incision. Velpeau saw such a phlegmon follow inflammation of the bursa beneath the ilio-psoas tendon on the brim of the pelvis; and in another instance a suppurating bubo excited abscess in the left iliac fossa by

direct continuity of inflammatory action. Inflammation beginning in the pelvic cellular tissue is anatomically prone to spread to the iliac fossa.

Diagnosis.—The ilio-pelvic abscess has often been mistaken for pelvic peritonitis, and sometimes for ilio-psoas, or psoas abscess.

In iliac abscess, the constitutional disturbance is for a time often very slight; it is only after prolonged suffering or suppuration that the digestive organs fail, and that the patient emaciates or becomes hectic. In pelvic peritonitis, on the other hand, fever, vomiting, and hiccough, are early and severe symptoms; and whatever swelling is appreciable is in the vaginal *cul-de-sac*, not in the iliac fossa, and rarely in the hypogastrium, except in those cases already referred to in which circumscribed peritoneal abscess occurs from cancerous enlargement and ulceration of the uterus. The swelling, moreover, in pelvic peritonitis is doughy in character, not hard, resisting, or elastic. Pelvic peritonitis is always symptomatic, and is most frequently brought about by inflammation of the ovaries or Fallopian tubes; hence, in doubtful cases, the coexistence of some affection of these organs favors the diagnosis of peritonitis rather than that of ilio-pelvic abscess. The tumor which it forms is due to matting together, as a consequence of the inflammation, of the intra-pelvic viscera; and the purulent collections, when such occur in cases of pelvic peritonitis, are intra-peritoneal, not in the cellular tissue of the pelvis or iliac fossa. Jarjavay,¹ Lefort, and Goupil have demonstrated four layers of aponeurosis within the upper part of the broad ligaments, constituting a kind of fibrous frame of the upper border and determining its shape, and completely shutting off the organs contained within it—viz., the tubo-ovarian apparatus, the round ligament, and the utero-ovarian vessels—from the cellular tissue situated within the external or serous envelop of the ligament. Thus, as M. Bernutz² points out, abscesses developed in the cellular tissue of the broad ligament are below this aponeurotic sheath of the Fallopian tube and ovary, and the pus almost necessarily tends towards the abdominal walls, or else to the deep iliac fossa.

In acute cases of iliac and ilio-pelvic abscess, especially some of those which are caused by injury, the symptoms are, however, severe from the first, and do not subside until pus is evacuated either into the bowel, bladder, or vagina, or externally. Dr. Bowditch³ has published a case which is illustrative of the truth of this statement, as well as instructive from the point of view of prognosis and diagnosis:—

A Slater, aged twenty-five, was admitted into the Massachusetts General Hospital, having fallen a height of thirty feet, striking his face and hands. Intense pain in the lumbar and umbilical regions, with bloody urine, removed by the catheter, were the immediate symptoms. He continued to grow worse, the pain was violent, the abdomen was tympanitic and very tender, induration formed in the left lumbar and hypochondriac regions, and an inclination to point was evinced in the left inguinal region at the end of the fourth week from the injury. On introducing a tube into the rectum to relieve the flatulent distension of the bowels, a large quantity of pus and mucus, and a little feces came away. The swelling in the inguinal region and general tympanites nearly wholly disappeared thereupon; but pus continued to be discharged daily from the rectum, and the patient left, “much relieved,” within two months from the accident. But he never recovered. Six months afterwards he was phthisical; in another month, he again had severe pain in the left groin, and in still another month, or thereabouts, “a tumor, tympanitic, disappearing on pressure, painful, and gurgling” was detected in the left groin, and diagnosed to be psoas abscess. The patient died within eleven months of the injury,

¹ Anatomie Chirurgicale, t. ii. p. 596.

² Bernutz and Goupil, Clinical Memoirs on the Diseases of Women, New Sydenham Society's Transl., vol. ii. p. 4.

³ First Med. and Surg. Report of the Boston City Hospital, p. 64. 1870.

and at the post-mortem examination there was found a large abscess in the left iliac fossa, opening into the bowel two feet from the anus; and from this abscess pus had burrowed down under Poupart's ligament into the thigh, five inches below the anterior superior spinous process.

This case shows that, even though an abscess of this sort opens into the bowel, and free evacuation is followed by apparent convalescence, there may remain behind a residuum of disease, which may be easily aroused into further and fatal suppuration. Nor can one resist the conclusion drawn by Dr. Bowditch, that if an opening had been made at an early period, or even just before pointing and the fistulous opening into the intestine occurred, a fatal result might have been prevented, nay, even a perfect cure effected. Dr. Bowditch attributes the phthisis to the undermining of the health by the abscess and the prolonged discharge from it; but whether this was so or not, the impaired health from lung-affection found a focus for further mischief in the remains of the iliac abscess with its communication with the bowel; and one of the worst forms of abscess was soon induced, namely, a tympanitic, gurgling abscess, due to the ingress of fecal gas through the only existing aperture available for drainage.

In some cases the symptoms simulate rheumatic affection of the hip-joint. Dr. Louis Atlee, who has given a concise account of iliac abscess in the *American Journal of the Medical Sciences*, October, 1883, there records a case of abscess in the left iliac fossa, after labor of thirty-six hours' duration, in which for a month the illness was mistaken for rheumatic disease of the left hip-joint. The case is of further interest as showing the burrowing character of iliac abscess, and as a set-off against Dr. Bowditch's case; for in Dr. Atlee's case, recovery took place after a slow convalescence:—

A swelling appeared in the left iliac fossa eighteen days after the commencement of pain, and subsequently a left gluteal swelling was opened and a large quantity of pus escaped. At a later period, a swelling formed in the linea alba, midway between the umbilicus and pubis, and after bursting discharged a pint of pus. Rather more than three months after the commencement of the illness, a quantity of pus was discharged by the rectum, and from this time the patient slowly recovered.

Mr. Mitchell Henry has published¹ the case of a sailor, aged 20, who came into the Middlesex Hospital on December 19, 1849, complaining of pain in the loins and left hip-joint, and moving so like a person laboring under *morbus coxarius* as to lead to his being classed among the patients for admission into the surgical wards. Examination showing that there was no active disease of the hip-joint, he was sent into a medical ward, on the supposition that he might have disease of the kidney. It was found that he had been passing a large quantity of pus with his urine for three weeks; on December 22, he began to pass blood with his water, and the purulent deposit continued; on December 26, the blood had ceased, but the pus continued to pass; on January 3, he died in much agony, but conscious to the last. At the post-mortem examination, the abdominal cavity was found to be filled with pus from an abscess, and not the result of peritonitis. The peritoneum was in an early stage of general inflammation. The bladder contained pus, and was perforated just beneath the peritoneum by an ulcer as large as a sixpence; and it thereby communicated with a large abscess in the situation of the left vesicula seminalis, which was nearly destroyed by suppuration. There was no disease of any other structure or organ in the body. Mr. Henry remarks, that, though acute inflammation of the vesiculæ seminales is not likely to occur, chronic inflammatory processes are not infrequent, and may occasion abscesses, the exact diagnosis of which must be difficult. Such abscesses might be confounded with suppuration in the prostate gland, with disease of the hip-joint, with intra-pelvic abscess, and the like. He also describes a very similar case communicated to him by Mr. Cock, of Guy's Hospital, in which hip-joint disease had been thought to exist, but was decided by Mr. Cock not to be present; the abscess was detected and opened through the rectum, and the patient recovered.

¹ *Med.-Chir. Trans.*, vol. xxxiii. p. 306.

Symptoms.—The tumors to which ilio-pelvic abscesses give rise, are often appreciable to the eye and touch in the inguinal and hypogastric regions, and are scarcely within reach of the finger in the vagina. There is an absence, at any rate for some time, of the general symptoms of peritonitis; whereas in purulent or sero-adhesive pelvic peritonitis with swelling similar to that of ilio-pelvic abscess, the diagnosis will rest upon the existence of the general symptoms of peritonitis in the one case, as compared with those of inflammation of the cellular tissue on the other. (Bernutz.) Fatal acute peritonitis may, however, be excited by extension of inflammation from an iliac abscess, as the following case proves:—

Mary S—, aged 17, a domestic servant, unmarried, was admitted into the Middlesex Hospital, under Dr. Coupland's care, on December 4, 1882, complaining of a severe and constant cutting pain in the lower part of the belly; the pain was much aggravated by micturition. Three weeks before this date she had miscarried (about the third month of pregnancy), after lifting a heavy coal-scuttle. She did not feel very ill at the time, and, after lying down for a while, resumed her usual duties. At the end of a week she commenced to experience more abdominal pain, and took to her bed for a few days. Then feeling better she resumed her work, but the pain returned with increased severity, and she sought admission into the hospital. She was a fairly nourished, but anæmic blonde, and was evidently suffering extremely. The pulse was small and rapid (140); temperature 99.8° F. On examination the abdomen appeared much distended, and in the hypogastric region (where marks of recent leech-bites were seen) there was an area of resistance and tenderness, reaching from the pubes to midway between this point and the umbilicus, and extending laterally for two inches on each side of the median line. There was dulness on percussion over the central part of this area; but elsewhere the abdomen was tympanitic. There was also general tenderness, although this was not marked in the region indicated. Belladonna was prescribed, and hot fomentations were applied. An enema was administered, and this was followed by a copious evacuation. The patient's condition on the following day was not improved, and she vomited once in the evening. On Dec. 6, the temperature rose to 103.4°; the pain increased; the tongue was dry, and about 7 P. M. vomiting again set in, accompanied by collapse. Death occurred at 10 P. M. The post-mortem examination was made by Dr. Fowler. On incising the abdominal wall, the sac of an abscess was discovered just above the symphysis pubis; it was triangular in shape, the apex pointing upwards, and it was situated behind the tendons of the recti muscles. It measured about two and a half inches on each side. The peritoneum was everywhere intensely inflamed, covered with recent lymph, and injected; and on the right side of the pelvic brim there was a sac about the size of an orange, with thickened and pigmented walls, communicating by a pin-hole perforation with the above-mentioned abscess. This sac was formed in the sub-peritoneal tissue covering the psoas and iliacus muscles, and the peritonitis was apparently due to extension of inflammation, and not to rupture of the sac. The uterus was rather larger than usual, and contained some extravasated blood. The bladder, rectum, vagina, and ovaries were normal. The spleen was small, but normal; the liver pale and soft; the kidneys slightly congested; the heart natural; the lungs somewhat engorged.

In ilio-pelvic abscess retraction of the thigh may exist, as it does in ilio-psoas, and occasionally in perinephric abscess. Phlegmons of the iliac fossa, when they occur, as they most frequently do, in the puerperal state, begin with abdominal pain and febrile reaction about eighteen or twenty days after labor. The pain is not sharp, like that of pleurisy, but dull and throbbing, like that of boil or abscess elsewhere. "True phlegmons of the broad ligaments," says Bernutz,¹ "seem to be frequently a kind of early manifestation of puerperal fever itself—a sort of critical abscess; and like the phlegmons of the superficial iliac fossæ, they have many points both of resemblance and of difference with pelvi-peritonitis. The hypogastric swellings, charac-

¹ Bernutz and Goupil, op. cit., vol. ii. p. 150.

teristic of both affections, have these points in common; they are deep-seated, they push aside the intestine so as to fill the iliac fossa; and neither the one nor the other shows, at first, any very marked sign of phlegmon, which will appear subsequently in inflammation of the cellular tissue, but be absent altogether in cases of pelvi-peritonitis." Obstinate vomiting, colliquative diarrhœa, and pains in the legs, loins, and pelvis, sometimes precede or accompany the general symptoms of pelvic inflammation, and the lower limbs may become œdematous from plugging of the crural veins, as the following case of M. Brouardel, quoted by Bernutz, shows:—

L. M., aged 21, one week after labor experienced pains in the legs, loins, and pelvis. The pains were most acute in the left iliac fossa, and in the lower limbs, which became œdematous; she had obstinate vomiting and colliquative diarrhœa. An abscess subsequently formed in the iliac fossa, and made its way externally in the sacral region, where it discharged a good deal of pus. Hectic fever supervened, and she gradually sank, and died within five weeks. On post-mortem examination the peritoneum and abdominal organs were all found healthy; a fluctuating swelling existed in the left iliac fossa, due to pus which had burrowed in the iliac muscle; the broad ligaments, ovaries, and Fallopian tubes were healthy. The crural veins were obliterated by a clot, which had the appearance also of containing pus.

Though there is, as has already been stated, generally an absence of vaginal swelling, yet sometimes an induration, higher and less easily reached than in pelvic peritonitis, is felt in the later stages of these abscesses. Bernutz records a case in which there was a collection of pus between the two layers of the iliac mesocolon, resting above the broad ligament and readily discoverable by examination; it resulted from an extension of inflammation from an abscess which filled the iliac fossa, and occurred in a woman who died of erysipelas in the course of these puerperal phlegmons.

Treatment.—The treatment will be the same as for other forms of intra-pelvic or abdominal inflammation. Absolute rest, and the use of opium, hot fomentations, liquid nourishment, and gentle laxative medicine to prevent an accumulation within the bowels, are the measures indicated. As soon as fluctuation is detected, a puncture or an incision should evacuate the pus; but fluctuation should not be waited for, and if there is reasonable ground for suspecting pus, it should be searched for with a large grooved needle or fine trocar, and a free escape and drainage should be provided. Though recovery will often take place as soon as the pus has been discharged into the bowel, vagina, or possibly even the bladder, yet fatal consequences sometimes arise after and from this event, and, moreover, it can never be determined that this will be the course taken by the abscess, which may just as likely set up fatal peritonitis by extension of inflammation to, or by bursting through, the peritoneum. A good plan of applying continuous warmth to the abdomen is by means of Leiter's coil,¹ which I have used somewhat extensively and can strongly recommend.²

IX. OVARIAN ABSCESS.—Ovarian abscess is very rare, and its correct diagnosis during life is much rarer still. In fact, it is generally extremely difficult, and sometimes quite impossible, to diagnose it at all.

Causes.—Abscess of the ovary is said to occur most frequently in association with pelvic suppuration after labor.

¹ A modification of Petitgand's mediate-irrigation coil. See Fig. 287, Vol. II., page 175, *supra*.

² See, in connection with the subject of ilio-pelvic abscess, Velpeau et Bérard, *Manuel d'Anatomie Chirurgicale*; Grisolle, *Les tumeurs phlegmoneuses des fosses iliaques* (*Archives Générales de Méd.*, t. iv. 1839); Bernutz and Goupil, *op. cit.*, vol. ii.

Sir James Simpson, Bernutz, Lawson Tait, and others have however recorded cases of abscess of the ovary resulting from acute ovaritis in child-bed, due to septic causes, but quite distinct from general septic peritonitis in which the ovary has become involved secondarily to the peritoneum. Apart altogether from pregnancy and parturition, it may be excited by any chronic source of ovarian irritation, and may be preceded by many years of ovarian, uterine, or other pelvic trouble.

I have recorded a case¹ in which fatal peritonitis was excited by a small abscess in the left ovary of an unmarried woman, aged thirty-two, who for six months had been subject to attacks of retention of urine and other bladder troubles, due to the presence of a myoma of the uterus.

Mr. C. J. Cullingworth² has published a case of abscess in both ovaries. The woman, aged forty-five, had for several months been losing strength, and for six weeks had suffered from vomiting and pain in the abdomen. The right ovary ruptured, and its purulent contents escaped between the layers of the abdominal parietes, giving rise to such a degree of abdominal swelling as to lead to the supposition that the case was one of suppurating ovarian cyst. The patient died of peritonitis, and at the post-mortem examination the uterus was found thickened antero-posteriorly, "owing to the presence in its anterior wall of three small fibroids, the largest of which was equal in size to a pigeon's egg."

Mr. Lawson Tait records³ the case of a woman aged thirty-eight upon whom he performed oöphorectomy, and in whose left ovary was an abscess containing about two drachms of pus, on the point of bursting into the peritoneal cavity. This patient had suffered for many years from great ovarian pains, and her catamenia occurred fortnightly, and, though scanty, were prolonged for a week or ten days. It is quite possible that in this case also some small uterine myoma may have been the cause of persistent ovarian irritation.

As abscess is an occasional termination of acute ovaritis, any of the causes which produce acute inflammation may lead to suppuration. These are violence, gonorrhœa, immoderate sexual intercourse, intra-uterine injections, the application of strong caustics to, and other operations upon, the uterus, the sudden suppression of the menses from cold, sudden shock, fatigue, etc. Andral mentions the case of a woman, aged thirty-six, who died from the effects of sudden menstrual suppression from cold; the left ovary was enlarged and contained pus. Wilks and Moxon "have met occasionally with pyæmic abscesses of the ovary, and an abscess in phthisis, but no tubercle." Tubercle is however another cause of ovarian abscess, and although tubercle of the ovary is usually, if not always, associated with tubercle of other organs, still this disease in the ovary may outstrip and overshadow that in any other of the affected parts, and through its secondary effects may cause death.

Mr. Cullingworth has published a second case⁴ of abscess in both ovaries, in a young woman aged 26, of strumous history and chronic ill-health, whose catamenia had been absent for twenty-seven months. As in his first case, so in this, the abdomen was uniformly enlarged; but in this case the enlargement was owing (1) to the greatly increased size of the suppurating ovaries; (2) to the effusion into and general thickening of the peritoneum; and (3) to the matting together of the intestines by old adhesions. Death occurred from peritonitis, and at the post-mortem examination several little masses of cheesy material, rather smaller than a pea, were found in the lungs near their posterior borders, and similar cheesy nodules existed in the kidneys and spleen. The right ovary measured $4\frac{3}{4}$ by $3\frac{1}{4}$ inches, and the left $7\frac{1}{4}$ by 5 inches. Both were filled with offensive pus, were displaced towards one another, and were adherent together by a band of

¹ Brit. Med. Journal, May 21, 1881.

³ Diseases of the Ovaries, 4th ed., p. 125.

² Lancet, Nov. 3, 1877.

⁴ Lancet, Nov. 10, 1877.

adhesion behind the uterus. The left ovary had been perceptible through the abdominal wall during life.

Pathology.—Inflammation set up by puerperal causes, involves the entire ovary, though, perhaps, the stroma only is affected at first. When excited by causes other than puerperal, it is frequently limited to the follicles of the gland. There are thus three conditions in which abscess is seen: (1) In puerperal cases, suppuration being set up equally throughout, the ovary is quickly converted into a pus-cyst. Of the other two conditions, the one is in most cases possibly but the earlier stage of the other. (2) Sometimes, as in the case referred to above,¹ the ovary suppurates at various points, several small collections of pus being seen on section. If one of these, not larger, it may be, than the rest, is near the surface of the ovary, periovaritis may be excited, purulent lymph may be deposited upon the organ, and ulceration or sloughing at some minute point may cause an explosion of fatal peritonitis. Here the suppuration has begun in the separate follicles of the ovary, and death has ensued before the several purulent depots have coalesced so as to form one considerable abscess. (3) In other cases, the fatal result does not take place until the various suppurating foci have united into a single abscess, and a large part of the organ has become a mere shell or cyst, filled with offensive pus. Either of the two latter conditions may be met with, whether the abscess has a tuberculous or a simple inflammatory origin. Sometimes the fatal termination is delayed until the abscess has expanded to such considerable dimensions as to be detected, on palpation during life, through the abdominal walls. Sometimes the inflammation in the ovary leads to occlusion and dilatation of the Fallopian tube of the same side; and the two together give rise to a swelling still more marked on vaginal or rectal examination, if not through the parietes of the abdomen. It is a common thing for the affected ovary to become agglutinated to one or several of the pelvic organs, or to the small intestines, appendix cæci, sigmoid flexure, or pelvic parietes. The adhesions thus formed often give rise to circumscribed spaces within the peritoneal cavity, and these, by recurring inflammatory attacks, become abscess-cavities, into one of which the abscess may burst. In other cases the ovarian abscess bursts into one of the adherent viscera, and thus may discharge itself externally through the vagina, rectum, or bladder. In other cases, again, it bursts into the general peritoneal cavity, but the inflammatory thickening of the peritoneal coat of the ovary often prevents this happening for a long time, if not altogether. The abscess may burrow beneath adhesions within the peritoneum, in addition to bursting through a pelvic viscus; and by the agglutination of the structures in the pelvis the ureter may be so compressed, inflamed, and thickened, as to lead to the same consequences to the kidney as are so often caused by stricture of the urethra, cancer of the uterus, etc. The following case is in point:—

A married woman, aged 33, was admitted into the Middlesex Hospital, under the care of Dr. Powell, on November 3, 1882, for what was supposed to be strumous pyelitis. After two months of extreme illness she died; and at the post-mortem examination the left ovary was found adherent to the rectum and tissues around. It contained a dark, blackish tract of inflammation, and was in communication with the rectum by a small sinus which opened into an abscess within the gland. This abscess was also in communication with a sinus which passed above the bladder, beneath some coils of intestine which were closely adherent to that viscus, and on separating which the sinus was exposed. This sinus ended in a *cul-de-sac*, formed by the right ovary and some adhesions around it, and contained pus. The great omentum was adherent to the peritoneum of the pelvis. Besides the communication between the ovarian abscess and the rectum,

¹ Brit. Med. Journal, May 21, 1881, p. 793.

there were two other communications with the rectum, close to the first, but leading into an abscess-cavity by the side of the ovary. The left ureter was much thickened and inflamed; the greater portion of the secreting structure of the left kidney was destroyed; four ounces of creamy pus were contained within it, and the organ was somewhat similar to a sacculated kidney. The bladder was full of pus, but there was no cystitis.

Tubercular ovaritis is very analogous to tubercular orchitis: there is in each organ an admixture of pus and softened tubercle; and, as in the case of the tuberculous testis the epididymis and vas deferens become the deposit of tuberculous material, which infiltrates their lining membrane and often breaks down into pus, so in the case of the ovary, the Fallopian tube suffers in the same way. Further, the serous and purulent effusions and the tubercular inflammation of the tunica vaginalis testis, find their equivalent in the pelvic peritonitis of the female. Tubercular disease of the mesenteric glands and miliary infiltration of the lungs are found associated with tubercular ovaritis as well as with tubercular orchitis. Bernutz points out a further analogy still, for he says:—

After puncture, pus, and with it, as we have found, part of the ovary, escapes, *per rectum*. This evacuation is followed by a temporary improvement, similar to that which follows in tubercular orchitis, when a puncture or incision of the distended tunica vaginalis allows the escape of pus and testicular *débris*. Then follow alternations of improvement and exacerbation, during which the constitution becomes seriously altered, and signs of pulmonary tubercularization appear, just as obtains in tubercular orchitis.¹

Symptoms and Diagnosis.—Ovarian abscess may be preceded by the symptoms of acute ovaritis, or it may occur so insidiously as to excite no symptoms until the pelvic peritoneum is inflamed. In the first case, pain will be complained of in the lower part of the abdomen, groin, and inner side of the thigh, and this will be accompanied with considerable febrile disturbance, restlessness, and nausea. The pain varies, being sometimes very intense, but more frequently only a continuous, dull aching, with recurring, severe exacerbations. If the pelvic peritoneum be involved in the inflammation, other symptoms will be added according to the precise part of the serous membrane which is inflamed; thus, if it be the peritoneal covering of the bladder, micturition will be frequent and painful; if that of the colon, sigmoid flexure, and rectum, tenesmus, with the accumulation of scybala, may result.

Vaginal examination shows the uterus to be unaffected, but on pressing the finger against the top of the vagina, on the affected side, extreme tenderness will be detected.* Probably the inflamed ovary will be felt to be enlarged and lower in position than the sound one; with the finger in either rectum or vagina it will seem to be about the size of a walnut, movable, and exquisitely sensitive. The formation of pus may be indicated by rigors; elevation of temperature, and increased frequency and feebleness of the pulse, with a red and glazed tongue, are pretty sure to occur. Sickness will be troublesome, and a sense of weight and throbbing pain will be experienced over the greater part of the lower half of the abdomen. Pus may however form without giving any indication of its existence, as in a case recorded in the *Lancet* for 1852.²

If the abscess is not preceded by the symptoms of ovaritis, there will be nothing to suggest its onset, and its course is pursued unnoticed until symptoms due to secondary pelvic peritonitis and adhesions occur. Indeed, in the majority of instances the diagnosis of ovarian abscess is never made, and the abscess is discovered only on the post-mortem table; whilst during life the

¹ Bernutz and Goupil, op. cit., vol. ii. p. 23.

² *Lancet*, July 24, 1852, p. 75.

symptoms are attributed to pelvic peritonitis, pelvic cellulitis, or "inflammation of the bowels." Yet a vaginal or rectal examination would clear the way to a right diagnosis by disclosing an enlarged, elastic, and tender swelling, of the size and in the situation of the ovary.

Prognosis.—The abscess may remain a long while without rupturing. Occasionally there are observed in the post-mortem room such changes in the pelvic peritoneum and cellular tissue, and in the ovary, as to lead to the impression that the ovary has at some former time been the seat of suppuration, and that recovery has followed the rupture of the abscess. It must, however, be admitted that other lesions may produce the same appearances, and further, that the more probable effect of the bursting of an ovarian abscess inwardly is death, either from shock or acute peritonitis, or from the burrowing or extension of a pelvic abscess which has been circumscribed for a while by inflammatory adhesions formed before the rupture has occurred.

Should the abscess burst into the bowel, vagina, or bladder, temporary relief or permanent cure may result, but not unfrequently the opening closes and the abscess cavity refills again and again, until the patient is worn out by suppuration or killed by blood-poisoning. The extent to which suppuration within and behind the pelvic peritoneum may occur, and the multiple fistulous communications which may be formed with the intestines, bladder, and external surface, as the result of ovarian suppuration, have already been alluded to in previous sections of this article. It is sufficient to say here that general peritonitis, pelvic peritonitis, pyelo-nephritis and renal abscess, cellulitis, iliac abscess, and diffused abscess in the abdominal parietes (see one of Mr. Cullingworth's cases especially), are some of the various complications to which abscess of the ovary may give rise, and that either of them may have a rapidly fatal result.

Treatment.—Prior to suppuration, treatment should be directed to overcome the ovaritis, or, when possible, to remove the cause which has set up the ovarian irritation. When suppuration has occurred, the question of relief by operation must be considered. If the abscess is pointing towards the vagina or rectum, it should be opened with a trocar or bistoury, and when possible drained. If it does not point in any accessible direction, abdominal section followed by the removal of the diseased ovary ought to be performed. I should not hesitate in future in following the teaching of Mr. Lawson Tait, in this class of cases, namely that, when the health is destroyed or life threatened, and when the condition is not evidently due to malignant disease, an exploratory operation should be performed, and the diseased uterine appendage removed. If the cause of the ovarian disease were a uterine myoma, such an operation, besides removing the diseased ovary, would also have a beneficial effect upon the uterine growth, and there would therefore be a double reason for performing it, unless, as in my case above referred to,¹ the tumor by its pressure had already completely disorganized the kidneys and ureters. Mr. Tait records, in the last edition of his work on Diseases of the Ovaries,² two successful cases in which this operation was performed.

XI. HÆMATO-SALPINX, HYDRO-SALPINX, AND PYO-SALPINX: ABSCESS OF FALLOPIAN TUBE.—*Hæmato-salpinx*, or distension of the closed Fallopian tube with blood; *Hydro-salpinx*, or dropsy of the Fallopian tube; and *Pyo-salpinx*, or distension of the closed Fallopian tube with pus, are conditions of great clinical importance, and likely to become still more so now that it is clearly proved that they can be very successfully remedied by surgical ope-

¹ Brit. Med. Journal, May 21, 1881.

² Op. cit., p. 332.

ration. Further information is however required to render their diagnosis more certain and more generally understood.

Hæmato-salpinx not unfrequently complicates the distension of the uterus from retained menstrual fluid, in cases of atresia or obstruction of the uterus, vagina, or vulva. The Fallopian tubes, thus distended, may either rupture or lead to the escape of blood into the peritoneal cavity. Simple hyperæmia of the tube, when part of a general congestion of the sexual organs, may cause either hæmato-salpinx, or the effusion of more or less blood into the peritoneum.

Hydro-salpinx and pyo-salpinx are met with as results of the same causes, all of which excite either catarrhal or suppurative inflammation in the Fallopian tube. The inflammation spreads along the tube to its fimbriated end, and by causing localized pelvic peritonitis, and adhesion of the fimbriæ to the ovary or to the neighboring structures, results in the closure of the distal end of the tube. As the uterine extremity becomes occluded by the same inflammatory process, the tube is thus shut up, and then becomes distended with the secretion poured forth from its lining membrane. It is usually towards the distal or trumpet-shaped end that the chief distension occurs. Occasionally, instead of a simple, elongated, sac-like swelling, several small sacculated swellings form, and the tube then looks more like a loculated pouch.

The mucous membrane of the tube is frequently discolored, and of a blackish-blue, slate, or purple tint. Its ciliated epithelium is desquamated, and the surface assumes a villous condition.

The contents of the distended tube may be either serum, sero-pus, mucopus, or pus. As the dilatation increases and the mucous membrane undergoes marked changes, the contents may be either thin, watery, and colorless—giving the tube, as Rokitsky describes it, “the appearance of a transparent, sero-fibrous bladder;” or variously colored—of any shade between green, yellow, red, brown, and inky-black—and syrupy, or more or less thick and flocculent. The accompanying particulars of all the cases which have been observed in the post-mortem room of the Middlesex Hospital during the last two or three years, have been supplied to me by my colleague Dr. Fowler. (See Table.) They bring out several important points connected with these pathological changes. The degree of distension varies, but it often attains the size of a goose’s egg or larger. The result of these changes in the tube is nearly always to cause matting together of the fimbriated end of the tube, the ovary, intestines, uterus, and pelvic wall. These adhesions are often much contracted and puckered, and, as Bernutz has very fully pointed out and illustrated by numerous cases, other lesions of the pelvic peritoneum are excited by the tubular disease. In some cases, a true purulent cyst is formed by the pelvic peritoneum; in others, a small muco-purulent cyst between the ovary and the tube is met with in the midst of numerous adhesions. Bernutz thinks that the peritonitis is sometimes excited by simple contiguity, and sometimes by the escape of morbid secretions from the tubes into the pelvic cavity. He argues too, with much force and at great length, to prove that these lesions of the Fallopian tubes are the very frequent cause of pelvic peritonitis. Mr. Lawson Tait, referring to a class of cases in which recurrent attacks of severe pelvic peritonitis occur in women in whom distinct tumors, on one or both sides of the uterus, are felt at some examinations, whilst at others no trace of them is detectable, says, “I have so much more frequently found the Fallopian tubes at fault, that I am inclined to believe that in the great majority of these cases of recurrent pelvic peritonitis, due to rupture of a cyst, it is in the tubes that we shall find the origin of the mischief,” rather than in the bursting of small ovarian cysts.

CASES OF HYDRO-SALPINX AND PYO-SALPINX IN THE MIDDLESEX HOSPITAL.

Case.	Age.	Hydro-salpinx.	Pyo-salpinx.	Right.	Left.	Double	Cause of death.
1	29	..	1	..	..	1	Acute peritonitis.
2	37	1	..	..	..	1	Dropsy.
3	32	..	1	..	..	1	Peritonitis.
4	45	..	1	..	..	1	Asthenia.
5	36	..	1	..	..	1	Perforation of bowel ; peritonitis.
6	21	1	..	..	..	1	Oedema glottidis.
7	34	..	1	..	..	1	Exhaustion.
8	54	1	..	..	1	..	Asthenia.
9	43	1	..	..	..	1	Peritonitis.
10	32	..	1	1	..	..	Septicæmia.
11	46	..	1	..	..	1	Peritonitis.
12	41	..	1	..	..	1	Peritonitis.
13	41	..	1	..	..	1	Peritonitis.
14	39	..	1	1	..	..	Peritonitis.
15	21	..	1	..	..	1	Asthenia.
Totals		4	11	2	1	12	
Average age in hydro-salpinx, 39 years.							
No. of cases of hydro-salpinx, 4 (1 on left side, 3 on both sides).							
Average age in pyo-salpinx, 36 years.							
No. of cases of pyo-salpinx, 11 (2 on right side, 9 on both sides).							
There were recent adhesions in the pelvis in 2 cases of pyo-salpinx.							
"	"	old	"	"	"	9	"
"	"	no	"	"	"	"	"
"	"	no	"	"	"	"	"
"	"	old	"	"	"	"	"

Causes.—Inflammation of the Fallopian tube is a not infrequent result of the puerperal state; it may be caused also by extension by continuity from the vagina or uterus, when these are the seat of catarrhal inflammation or ulceration. It is more than probable that the mischief in some instances arises in the ovary, ovaritis or periovaritis preceding the inflammation of the tube and its adhesion to that organ. Certain it is that abscess in the ovary coexists with pyo-salpinx, as the cases registered by Lawson Tait¹ and Bernutz prove.

In 1880, a woman, aged twenty-nine, who was admitted into the Middlesex Hospital under the care of Dr. Edis, shortly died of acute general peritonitis. At the autopsy, the intestines were found agglutinated and smeared with soft greenish lymph. A very large quantity of pus filled the posterior *cul-de-sac* of the pelvis, and pus was seen to ooze from an abscess as large as a hen's egg, connected with the left ovary. The ovary itself was much swollen, and the Fallopian tube was of large size. The right ovary was twice as large as normal, and its Fallopian tube was dilated. The uterus, except that it was retroverted, was normal in its condition and position, and there were no adhesions about it.

Pelvic peritonitis, from whatever cause arising, may excite tubular inflammation; but probably the sequence of events is more often reversed, the peritonitis being the consequence and not the cause of the inflammation of the tubes. Any sudden check to the menstrual flux is said to give rise to tubal dilatation, as a consequence of tubal inflammation. Morgagni observed that the disease was commonly found in prostitutes, and thought that it explained the frequency of sterility in them. It is possible that the extension of gonorrhœal and leucorrhœal inflammation to the tubes and ovaries is the cause of the condition referred to by Morgagni as occurring in women of the town. Other causes than those above enumerated also exist. I have seen pyo-salpinx in a woman with a procident and ulcerated womb, and a very large hydro-salpinx in one who died of extensive cancerous disease of the uterus. Drs. Wilks and Moxon have met with it in association with chancre in the vagina. Septic metritis and endometritis are also known causes.

Symptoms and Diagnosis.—There is generally a history of long-standing pelvic or peri-uterine trouble, which probably has been referred to inflammation of the peritoneum or pelvic cellular tissue. Menstruation has probably been irregular for a long time: most probably profuse, at too frequent periods, and preceded and attended by considerable pain. Pain, which is more or less constant, as in ovaritis, is greatly increased also by exertion; and is so severe during coitus that all attempts at sexual intercourse cease. Thus in a double manner is sterility induced—by obstruction of the germ-duct and by cessation of sperm-injection. The symptoms do not yield to treatment, either medicinal or mechanical; incisions, dilatations, cauterizations, and the rest of the gynæcological manipulations of the os and cervix uteri being as unavailing as pessaries, leeches, and drugs. Digital examination, vaginal or rectal, will often discover a tender, more or less firmly fixed swelling at the situation of the ovary, or if the tubal affection be double, as it often is, a swelling may be felt on each side. Sometimes distinct fluctuation can be felt in the swelling. Mr. Lawson Tait tells us that the peculiar, sausage-like shape of the distended tube has frequently enabled him to diagnose correctly the presence of hydro-salpinx or pyo-salpinx.² On the other hand, the post-mortem room often corroborates the teaching of Bernutz, that the peri-uterine tumors discovered by vaginal examination, are frequently formed by the encysted inflammatory products of the pelvic peritoneum, even in cases in which the tubes are much distended. It may thus happen

¹ Diseases of Women, 4th ed., pp. 61, 62, 63.

² Ibid., p. 65.

that a correct diagnosis is based upon wrong premises; and too great reliance on the supposed nature of a peri-uterine swelling, may possibly lead the surgeon astray. The tubal swellings have to be diagnosed from the swellings of pelvic peritonitis, whether these are encysted collections of pus, or masses of viscera matted together. A small ovarian or broad-ligament cyst—especially if fixed by adhesions to the pelvis—or a hydatid cyst in the pelvis, might possibly give rise to confusion. But the more rounded outline of the former, especially as felt through the rectum, and the painlessness of the latter, will assist the diagnosis; whilst either ovarian or hydatid cysts will cause more mechanical interference with the bladder and rectum than do tubal distensions. The examination of the fluid withdrawn by the aspirator will clear up the diagnosis as regards the presence of a hydatid. Between tubal swelling and enlargement of the ovaries from inflammation or abscess, a diagnosis is not possible with our present knowledge. Nor is it of any great moment that this is so, because the same pathological changes are found, and the same operative treatment is required, in each class of cases. To attempt a diagnosis between hæmato-salpinx, hydro-salpinx, and pyo-salpinx, the clinical history and progress of the case must be closely studied. Mr. Tait says that the most common of the varieties of this disease is hydro-salpinx, and the rarest hæmato-salpinx.

Prognosis.—Unless the contents of the Fallopian tubes be removed by the surgeon, or discharged spontaneously through the uterus, or into some coil of adherent intestine, a fatal result must sooner or later occur from pyo-salpinx. Possibly in hydro-salpinx rupture into the peritoneum may occur, and a cure be effected in this way. Probably in some cases of hydro-salpinx and pyo-salpinx there are periodic discharges through the uterus during the catamenial relaxation of that organ, as Dr. James R. Chadwick, of Boston, supposes. If pus escape into the peritoneal cavity, fatal collapse or acute peritonitis will be the end. In other cases, death is brought about slowly by exhaustion from repeated attacks of pelvic peritonitis, and the interference with the functions of important organs by adhesions and contractions of pelvic structures; by the burrowing of pus, the formation of visceral fistule, and the septic absorption of decomposing pus and gases contained within the abscesses.

Lawson Tait writes:—

In its acute stage, inflammation of the tubes is a most formidable disease, and so rapidly ends in general peritonitis that we can hardly recognize the necessity for interfering before it is too late to do anything. I have seen several fatal cases of peritonitis which undoubtedly had their origin from inflammation of the Fallopian tubes, and which ought to have been treated by abdominal section. . . . Pyo-salpinx is, however, a more chronic condition. . . . Probably they all arise in some acute inflammation, which occludes both openings of the tubes, and converts one or both tubes, generally both, into chronic abscesses; yet in the last case I have narrated, there was in the history no incident of an acute kind. Dr. S. Wilks has met with two cases where pyo-salpinx caused general pyæmia, one case proving fatal from an abscess in the liver, the other from an abscess in the brain.¹

Treatment.—Owing, perhaps, in part to the imperfection of diagnosis, but chiefly to the fact that until lately no serious thought was given to their surgical treatment, these cases have scarcely been submitted to any but expectant and ameliorating remedies. Puncture *per vaginam* for their evacuation has been advised, but much uncertainty as to what the nature of the swelling to be tapped really was, has generally been mingled with the advice. Moreover, tapping has not very often been followed by permanent relief.

¹ Op. cit., p. 69.

To Mr. Lawson Tait belongs, I believe, the credit of having first shown that complete cure will follow the removal of the uterine appendages; at any rate he has enforced this treatment both by argument and practice, and has thus made himself the advocate of a line of abdominal surgery which is almost certain soon to gain many supporters. Mr. Tait has now removed the uterine appendages for hydro-salpinx no less than twenty-four times, without a single death, and has done the same operation for pyo-salpinx twenty times with uniform success. He, however, warns surgeons that, owing to the adhesions and matting together of the appendages, these operations are the most difficult that he has ever performed—far more difficult than removal of an ovarian cyst with numerous adhesions.

The operation is done by making an abdominal section as for ovariectomy, and then removing the ovaries along with the tubes. Ligatures are used to control hemorrhage, and for the pedicles; the "toilette" of the peritoneum is carefully attended to, as in ovariectomy; and when hemorrhage is severe, or the tube ruptures during the manipulations, or many adhesions have to be separated, the pelvis should be drained for the first few days after the operation.

When owing to the firmness of the adhesions the appendages cannot be removed, the cystic swellings should be exposed by laparotomy and tapped with an aspirator. Then the puncture should be enlarged, and its edges stitched by continuous suture to the edges of the parietal wound, so as completely to close the peritoneal cavity. Mr. Lawson Tait has done this in six or seven cases with ultimate good results; but the process is neither as satisfactory, nor as rapid in its effects, nor as complete in its cure, as the entire ablation of the appendages.

XI. SUPPURATING OVARIAN CYSTS.—Suppuration of ovarian cysts, whether as the result of spontaneous or traumatic inflammation, is an infrequent occurrence. Complex multilocular cysts, and those with more or less solid material, are the most prone to suppurate. The size of the cyst has little or nothing to do with the tendency to inflame; for in some cases the patients have been ignorant of the presence of a tumor, until the onset of the acute symptoms, which precede and accompany suppuration, has drawn attention to its existence.

Causes.—It occurs sometimes without any known or traceable cause; but in most instances there is something which has definitely excited suppuration. Failing health, acute intercurrent disease, some neighboring inflammatory affection, the jolting and shaking of a long journey, and blows, falls, or other injuries, are exciting causes. It has been a common opinion that suppuration in an ovarian cyst is almost invariably the result of tapping or some other surgical interference, but this is by no means correct. Keith¹ records five cases in which tapping had not been performed, and in his other cases no symptoms came on in less than five weeks after tapping.

Symptoms.—Suppuration may be acute or chronic. In acute cases the symptoms are abdominal pain and tenderness, often most severe; dry and red tongue, with anorexia; pulse rapid and feeble, from 120–160; rigors and elevation of temperature, varying from 103° to 105° F. at night, and from 100° to 102° F. in the morning; exhaustion, loss of flesh, and profuse perspirations; vomiting and diarrhœa; sallow, shrivelled, and unhealthy countenance, and perhaps putrid discharge from the umbilicus, or elsewhere—all forming a group of symptoms sufficiently characteristic. Often the brain remains clear throughout a long and miserable illness; but in other cases the eyes become dull and vacant, the senses are deadened, and delirium occurs. As regards tempera-

¹ Edinb. Med. Journal, February, 1875, p. 686.

ture, though a marked elevation is the common change, Keith has recorded two, and those the most hopeless-looking of all his cases, in which there was striking lowness of temperature: in one the thermometer registered 95.5° to 96.5° F.; yet the contents of the cyst were intensely putrid, and for some days before the operation there had been a steadily rising pulse with the steadily falling temperature; in the other case, the cyst had burst into the peritoneum, and at the time of the operation the temperature was 97° F.; in both these cases the temperature rose within six hours after the removal of the tumor, in the first from 95.5° to 97° F., in the second from 97° to 100.5° F. Keith remarks: "The statement, that, when there is pain or tenderness, this generally arises from inflammation of the peritoneal surfaces, requires modification; the reverse is oftener the case. Tenderness or pain, if long continued, is almost always a certain sign that irritation is going on in the tumor somewhere. Simple surface-tenderness causing surface-adhesion, rarely lasts long; and the worst cases of adhesion met with have often no history of either pain or tenderness." If tapping is performed, the cyst rapidly refills, and typhoid symptoms are prone to come on, sometimes with great rapidity. In chronic cases there may or may not be general tenderness or pain. There may be no rise of either pulse or temperature, and the general state of health may be fairly good, or even apparently robust. On the other hand, pain on walking or moving may be sufficient to cause the patient to keep her bed for many months.

In one of Keith's cases a very severe attack of inflammation occurred, and the tumor had existed during at least one pregnancy, yet every symptom of irritation, pain, and tenderness had subsided some months before the operation.

Diagnosis.—In acute cases, and in the advanced stage of suppuration, there is no difficulty in diagnosing the condition by the symptoms above enumerated. In chronic cases, and in the early stage of suppuration, the diagnosis is most obscure. When the temperature is low, the surgeon may be thrown completely off his guard, and may suspect neither inflammation nor suppuration. From acute and suppurative pelvic peritonitis, and from acute pelvic cellulitis and abscess, these changes in ovarian cysts may be distinguished by the following characters:—

(1) Ovarian tumors have an abdominal as well as a pelvic portion, the latter being in most instances in front and to one side of the displaced uterus. (2) The uterus though displaced backwards and to one side, is yet not fixed by peri-uterine induration. (3) The tumor presents a more or less globular outline, and obscurely fluctuating resistance.

From pelvic peritonitis, an inflamed ovarian tumor is further distinguished by the very mild character of the peritonitis, and generally by the unaltered size and outline of the swelling after the peritonitis has subsided.

Prognosis.—When left to themselves, suppurating ovarian cysts almost invariably end sooner or later in death. Occasionally the cyst bursts into the vagina, bladder, rectum, or some higher part of the bowel, or externally, and then if the cyst be unilocular, recovery may take place after many months of illness and suppuration. Much more frequently, however, the patient dies of exhaustion, hectic, or septicæmia, after tapping or bursting of the cyst; or the cyst ulcerates or bursts into the peritoneum, and collapse or acute general peritonitis kills the patient; or if the cyst is not tapped and does not burst, the patient dies from the pressure and dragging effects of the tumor, that is, from dyspnoea, syncope, uræmia, vomiting, diarrhoea, or intestinal obstruction.

Very rarely the cyst when inflamed shrinks, and so much diminishes in size as to become unnoticeable; but this does not happen if the cyst suppurates. Years after the spontaneous discharge of pus and blood from an

ovarian tumor, fresh inflammation may be lighted up in the remains of the cyst. Such was probably the course of events in a case described by M. Goupil,¹ in which a tumor burst and discharged *per vaginam*, when the girl was in her eighteenth year; at twenty-nine a violent attack of pain was followed by metrorrhagia, and at thirty-three a tumor existed in the right hypogastrium, continuing painful for one month, and then subsiding in size under treatment.

Treatment.—Until comparatively recently, these cases had been left to the merciless course of the disease; or at best, attempts to give temporary ease from pain and distension by tapping, had been made. As a step in advance of simple tapping, free incision and drainage were adopted, and a few cases in which this practice was followed recovered. Incision and drainage have been made through the abdominal wall, through the vagina, and through the rectum, the first being the best; but few women are strong enough to bear the exhausting suppuration which goes on under these circumstances, sometimes for many months.

In December, 1864, Keith, of Edinburgh, performed ovariectomy upon a woman in a state of semi-delirium from septic fever, for a very large suppurating tumor.² His remarks thereon are so striking that I must quote his own words: "This was probably the first time that surgery broke in upon an acutely inflamed peritoneum. The intense lividity, amounting almost to blackness, of the abdominal contents, and the spongy tenderness of inflamed intestine, were then strange to me, though thought little of now. Recent lymph was present everywhere; adherent bowel and mesentery hedged in a thick-walled cyst, the base of which was in a complete state of slough. Inflammation had gone on to gangrene, and there was intense putridity. After an operation which went on for two hours, the patient was placed in bed, cold, vomiting, and nearly pulseless. It seemed as if we had simply killed her, yet she got rapidly into heat, the restless delirium at once disappeared, there were warm perspirations, much sleep, and a recovery without a drawback."³

In February, 1875, Keith contributed his classical article to the Edinburgh Medical Journal, and it marks a most striking era in the history of ovariectomy. Therein he records seven cases of acute suppuration of ovarian tumors which he had submitted to ovariectomy, and he tells us that up to that time he had operated in the same way upon ten acute and two chronic cases, and that in all save two of the acute cases the patients recovered. This result was obtained against what seemed to be very desperate odds; and in one case the cyst had actually ruptured into the peritoneal cavity, yet recovery followed the operation. In all these cases, where the temperature was very high before, there was a fall of several degrees within a very few hours after the operation. In only one of the acute and one of the chronic cases were there no adhesions; in others the adhesions were of the gravest nature, and the operations were tedious and severe. Indeed, Keith says of them—

"To an onlooker, few operations look so hopeless as those for the removal of acute suppurating cysts. The general condition is always unfavorable, and as a rule ovariectomy is in these circumstances tedious and severe. To be believed in, such cases need almost to be seen." Yet he concludes (p. 687), "The extreme feebleness of pulse and depression of the vital powers, which all cases of acute suppurating cyst present, must not deter one from operating. Hopeless without interference, they are not the unfavorable cases for operation that they seem, or, judging from the small number of reported successful results, have hitherto been regarded."

Ovariectomy in such cases must be, of course, followed up by the most scrupulous attention to the cleanliness of the peritoneum, before closing the

¹ Bulletin de la Société Médicale d'Observation, 1856.

² This case was reported fully in the Lancet, 1865.

³ Edin. Med. Journal, Feb. 1875, p. 674.

abdominal incision, and drainage through the lower angle of the wound is necessary. In a case of multilocular ovarian cyst jammed within the pelvis, and universally adherent to its viscera, pus escaped from one of the cysts during removal, and afterwards two or three others were found to have suppurated. A drainage tube was not introduced into the abdomen, but a thin, blood-stained serum escaped for three or four days from the lower angle of the ovariectomy wound. The patient made a good recovery, somewhat retarded though by an abscess in the abdominal wall. There was nothing prior to the operation to indicate the existence of suppuration in any part of the cyst.

HYDATIDS.

A *hydatid*, or, in other words, an echinococcus-cyst, is the larval form of a tapeworm—the *Tenia echinococcus*—which infests the upper intestines of dogs and wolves, and consists of not more than three joints. The formation of a hydatid cyst in man is very slow, and results only from the ingestion of the tapeworm eggs, which are swallowed with the food or drink; impure water, to which dogs have access, is a very common vehicle for these eggs in their passage to the human stomach.

A hydatid tumor consists of (1) a thick, gelatinous, elastic, gray, translucent bladder, having a laminated, hyaline structure; this is the *ectocyst* of Huxley; (2) a thin, delicate, soft, but not very elastic, membrane, lining the ectocyst, and having usually upon its inner surface crowds of minute bodies like white grains; this is the germinal membrane, the *endocyst* of Huxley, and it is, moreover, the essentially vital part of the echinococcus-cyst or “bladder-worm,” as the hydatid is also styled; (3) very minute buds or gemmæ which are produced by the endocyst, and remain for a time attached to it by means of a stalk, either singly or in groups, and are covered by a thin, delicate sac continuous with it; these buds are the minute, white grains seen on the inner surface of the endocyst, and they develop into *scolices*, or *echinococcus-heads*, which are the embryos of the *Tenia echinococcus*, and which have the anatomical characters of the head of the tapeworm; the double circle of hooklets, and the four oval suckers placed at regular intervals outside the hooklets, together with the head that carries them, may be seen either protruded from, or retracted within the little sac with which the head is continuous; (4) a quantity of clear watery fluid which distends the endocyst, and within which float numerous vesicles of various sizes, some of the smallest being still adherent to the germinal membrane. These vesicles are the secondary or daughter echinococcus cysts; and many of the larger contain a third, and these again a fourth generation. Dr. T. S. Cobbold, F.R.S., in a letter which he has written to me upon this subject, says: “The production of daughter and grand-daughter hydatids by proliferation or budding, has given rise to much controversy. Leuckart holds that these secondary formations ordinarily take their origin at different points between the lamellæ of the ectocyst. Naunyn, on the other hand, holds that the daughter-vesicles are special bud-developments of the endocyst. I think that the process as observed by Leuckart is exceptional: that the vesicles are abnormal scolices developed from buds of the endocyst; with Naunyn, I hold that the endocyst is primarily concerned not merely with the production of echinococcus-heads, but also with the formation of the secondary and tertiary hydatids, whether exogenous or endogenous. In other words, and in agreement with the views of Von Siebold, Wagener, and Bremser, it is thought that the secondary or

daughter bladders are, for the most part, either metamorphosed or imperfectly developed scolices, which, in their turn, may give rise to true heads."

The fluid in which these vesicles float is limpid and alkaline, of specific gravity 1007-1009, containing no urea, and but a trace of, if any, albumen; the presence of a large quantity of common salt, causes it to throw down a copious white precipitate with a solution of nitrate of silver. It may contain echinococci, or the hooklets of the echinococcus-heads, or shreds of the equally characteristic striated hydatid-membrane; but even without these structures, the hydatid fluid is distinguished by its chemical composition from every other fluid which forms in the body.

Outside the ectocyst there is commonly an investing capsule of greater or less thickness, derived from the inflammatory products found in the tissues in which the hydatid has implanted itself. This adventitious capsule adheres intimately to the organ or structure in which the tumor occurs, and is very freely supplied with blood.

Sometimes the hydatid cyst is barren, that is, there are no echinococcus-heads developed upon the endocyst, but fluid alone is contained within it. These barren cysts are aptly called *acephalocysts*. They are the form of hydatid cyst most readily cured by tapping. The various changes which hydatids may undergo will be referred to when speaking of hydatids of the liver. They may occur at any age, and in either sex, and are not limited to any particular organ, structure, or part of the body, but have been occasionally found in each one of them. The most common situation is somewhere within the abdomen; and the organ by far the most frequently invaded is the liver. In the large majority of cases where they have infested other parts and organs, they have originally occurred in the liver. Hydatid cysts may exist for years without destroying life, and even without being detected or suspected.

HYDATID CYST OF THE LIVER.—*Symptoms.*—The origin, and, for a time, the progress, of a hydatid of the liver are insidious, and it is not even suspected to exist until a perceptible tumor occurs. The tumor, when first detected, may be not larger than an orange, but it may grow to such a size as to fill the greater part of the abdomen. The natural outline of the liver is changed by it as it grows in an upward, downward, or lateral direction. The surface of the tumor is smooth and regular, unless, as occasionally happens, two or more distinct cysts project from the surface of the liver near together, and thus present a lobulated outline. The tumor is elastic, if not actually fluctuating. If there be none, or but a thin layer, of the liver-tissue overlying the cyst, fluctuation will be distinct, and a thrill or vibration indicative of fluid will be detected on palpation. The hydatid's growth is slow, and when found to be of large size, it has probably existed for years—perhaps for very many years.¹ Except from its weight, and the effects of pressure on surrounding parts, or from the embarrassment it causes to the breathing, it gives rise to no local inconvenience until it occasions inflammation of the peritoneum covering it, when attacks of acute pain and tenderness occur. Such attacks are not, however, common in hydatid disease. Oedema of the lower limbs, hemorrhoids, enlargement of the superficial veins of the abdomen, and ascites, are exceptional symptoms, but they are met with; and when they exist their cause is the pressure of the tumor upon the vena cava and vena portæ. Jaundice is rarely caused by hydatid of the liver, and, when present, it arises from one of three conditions, namely, pressure on the bile-duct, rupture of the cyst into the duct, or catarrh of the ducts. In rare cases the splenic vein may be engorged, or the ureter compressed,² by the hepatic cyst; or either the

¹ Bright, Budd, Murchison.

² Bright, Clinical Memoirs on Abdominal Tumors, etc.

spleen or kidney may be simultaneously the seat of a hydatid; otherwise the spleen is not enlarged, nor is the urine altered. Though the patient's health may be impaired through the functional disturbance of some neighboring viscus, the tumor does not excite fever or other constitutional irritation, and does not even materially disturb the proper functions of the liver.

Diagnosis.—The diseases which are most liable to be confounded with hydatid of the liver, are hepatic abscess; distended gall-bladder; cystic, and medullary, or other soft, solid tumors of the kidney; and effusion into the right pleural cavity. Aneurism and ascites may also possibly give rise to doubt. A large, simple cyst of the liver would be almost, if not quite, indistinguishable from a hydatid cyst of that organ; but then such simple cysts are very rare, whereas hydatid cysts are comparatively quite common.

(a) The slow and insidious character of its growth, and the absence of pain and constitutional symptoms, would serve to exclude abscess. If, however, the hydatid cyst should become inflamed, and suppurate, it would present all the local and constitutional characters of abscess, and the diagnosis would then depend alone upon the clinical history and the previous long existence of a fluctuating, painless swelling in the hepatic region. The prognosis and treatment in each class of cases would be the same.

(b) The shape and position of a distended gall-bladder, its usual mobility in a lateral direction, and the fact that its development is commonly preceded and accompanied by attacks of biliary colic, and frequently by jaundice, will point to its exclusion. It must, however, be remembered, that a hydatid cyst of the liver may be pendulous, and that the gall-bladder may become distended without attacks of colic or pain of any sort. A case is related¹ by Dr. S. F. Simmons, of a tumor occupying chiefly the left side of the abdomen of a woman; it was diagnosed to be a distended gall-bladder, but on post-mortem examination it turned out to be an enormous hydatid cyst, containing sixteen pints of hydatids of various sizes.

(c) Cystic and soft solid tumors of the kidney generally first present themselves in the loin, or if on the front of the abdomen, then lower down than the hepatic region. In their early stage, there is often a line of resonance between them and the liver dulness. Sometimes there is evidence in the urine of changed kidney structure and function, but its absence does not at all exclude tumor of this organ. I have seen, in several cases, cystic and solid tumors of the kidney without any sign of renal disease having been furnished by the urine; and soft, solid tumors of the kidney, mistaken for hepatic cysts, which have given the elastic if not fluctuating sense of fluid, and which have been aspirated without result. The rapidity of growth and the marked impairment of health in medullary cancer, sarcoma, and tuberculous disease of the kidney, will serve to distinguish those affections from a hydatid.

(d) Effusion into the pleura, attended with bulging of the ribs and intercostal fluctuation, might be suspected to be present, but a physical examination of the chest and the absence of constitutional symptoms would serve to indicate the hydatid nature of the swelling. In great pleuritic effusion the liver is pushed down, in hydatid enlargement the lung is pushed up. Hydatid of the liver may, however, cause, or coexist with, the pleuritic effusion.

The pain, pulsation, and bellows-murmur caused by aneurism of the abdominal aorta, and the same symptoms, together with jaundice, which are caused by aneurism of the hepatic artery; the constitutional cachexia, and the tender, hard, and uneven surface of the liver in cancer of that organ—would assist in distinguishing those diseases. In ascites, the parts of the abdomen which are dull on percussion are the lowest in position, and vary with posture; this is

¹ Med. Communications, vol. i. page 101. London, 1784.

not so in hydatid of the liver, even when the cyst is of enormous size. If ascites and hydatid of the liver coexist, the detection of the latter may be quite impossible until the ascitic fluid is removed. Finally, the hydatid character of a tumor will be at once made certain by an examination of the fluid withdrawn by the aspirator.

Prognosis and Modes of Termination.—Hydatid tumor of the liver may last for years without causing trouble, or without its presence being detected until after death. Its existence is compatible with perfectly good health; but after it has once attained a size large enough to be recognized, or to give rise to symptoms, if it be not cured by treatment it will go on growing, though possibly very slowly, until it bursts or causes death by the effects of its pressure. I have the notes of several such cases (detected only after death) from the post-mortem registers of the Middlesex Hospital, in which no indication of the hydatids' presence existed during life; none of these cysts, however, were larger than an orange or cricket-ball. Murchison taught that spontaneous cure was "confined for the most part to tumors of so small a size that they are not recognized during life;" and the notes now before me of cases taken from the Middlesex Hospital records, since the time when Murchison was one of the physicians of that hospital, entirely corroborate this statement.

By its pressure, the tumor may excite a fatal pleurisy, pneumonia, or peritonitis; by its rupture, various consequences follow, dependent upon the direction in which it bursts. If into the pleura, acute pleurisy and death are the almost invariable results; and this is the commonest direction, and on the right side only, rarely on the left, is the pleural sac invaded. When the lung becomes adherent to the diaphragm prior to the giving way of the tumor, the contents may escape into the bronchial tubes and be expectorated, and the patient may recover; on the other hand, he may die from gangrenous pneumonia, exhaustion, or pyæmia. Rupture into the pericardium is always, and rupture into the peritoneum nearly always fatal. Bright¹ mentions a case which is possibly one of recovery after rupture into the peritoneum, and Ogle, one of recovery after rupture into the omentum.² Rupture of the cyst into, after adhesion with, the stomach or intestine, is the most favorable termination, but it is not very common; in these cases the hydatids are slowly vomited or passed *per anum*. Death may, however, occur from exhaustion, peritonitis, hemorrhage from the sac, or multiple hepatic abscess.³ The cyst, after having formed adhesions with the parietes, may ulcerate and discharge externally at the umbilicus, or in some other part of the abdomen, or in one of the lower intercostal spaces. Though such cases do not commonly end in recovery, several are on record as having done well; in others the patients have died from peritonitis, hemorrhage from the sac, or prolonged suppuration from its walls. It is not very uncommon for a hydatid cyst to open into the bile-ducts⁴ or gall-bladder, and thus to occasion obstruction of the bile, and, as a consequence, jaundice and biliary colic. The entrance of bile into the cyst kills the parasite, and either leads to the withering up of the contents and spontaneous cure of the tumor, or lights up fatal inflammation and suppuration in its walls. In very exceptional cases such a cyst has opened into the vena cava, and caused instant death by impaction of some of its contents in the pulmonary artery. Death may be caused by the accidental rupture of a cyst within its bed. I have had such a case in my own practice:—

¹ Op. cit., New Syd. Soc. ed., p. 47.

² Trans. Path. Soc. Lond., vol. xi. p. 295.

³ Dr. Owen Rees, Med. Times and Gazette, June 20, 1857.

⁴ Trans. Path. Soc. Lond., vol. xvi. p. 160, and vol. xix. p. 256.

A boy, in good health, and not known to have any hepatic symptom whatever, fell, striking his belly upon a fender. He died almost directly from shock. At the post-mortem examination there was found a simple hydatid cyst in the right lobe of the liver, the size of an orange; the cyst had been in part detached from its bed in the liver, and there was a laceration one inch long in the surrounding liver-tissue. Blood had been effused into the cavity of the cyst; the liver capsule was intact.

Blood effused between the adventitious cyst and the hydatid cyst is occasionally a cause of death. Again, death may be caused in various ways besides by the rupture of the cyst: (a) By the effects of pressure on the stomach, ureter,¹ great bloodvessels, etc. (b) The tumor may attain such a size that it nearly fills the abdomen and interferes with respiration and the heart's action, as well as with the functions of the abdominal viscera, and so death is caused by exhaustion and marasmus. (c) The cyst may suppurate and the case terminate fatally from pyæmia. (d) Secondary hydatid tumors are apt to form, either in the liver or some other organ of the abdomen or chest, or in the brain, and then lead to death by the pressure or inflammation which they excite.

Abortive Terminations of Hydatid Tumors.—It has been stated that some of these tumors undergo so-called "spontaneous cure;" this means that the hydatid fluid is absorbed, that the vesicles burst or shrivel up, and that the contents generally are converted into a putty-like material, whilst the cyst-wall calcifies or thickens into a tough, leathery, or cartilaginous membrane. The contents of these withered cysts are not always of the same appearance: sometimes they are of creamy whiteness, and like cream-cheese; sometimes of a transparent yellow, or lemon color, having the appearance and consistence of calf's-foot jelly. Under the microscope, abundance of fat-globules and plates of cholesterine are to be seen, and generally shreds of the laminated hydatid-membrane, or hooklets of the echinococci, are to be found amongst the altered cyst-contents, though this is not always the case.

I have notes of a case in which the cyst compressed the vena cava, vena portæ, and common bile-duct, was the size of an orange, and was situated at the portal fissure. This cyst contained a clear hydatid fluid, but its walls were in places cartilaginous, and in others hard and coated internally with calcareous plates. The patient had died of phthisis. The causes of these various changes are either the calcification of the parent-cyst, or the overgrowth of one of the daughter-cysts leading to strangulation from within; or the entrance of bile into the cyst. It is possible that some intercurrent disease may interfere with the well-being of these parasites, and so lead to their abortive ending. I have notes of three cases of death from phthisis, in which shrivelled tumors of size varying from that of an egg to that of a cricket-ball, were found on post-mortem examination.

Treatment.—This resolves itself into the prophylactic and the surgical. Medicines are quite powerless to effect any influence upon a hydatid tumor. The ova of the *Tænia echinococcus* develop not only in man, from whose body they do not as a rule pass, but also in sheep, from whose bodies the echinococci are again set free in the slaughter-house, to be devoured by dogs and again developed into tapeworm. *Prophylaxis*, therefore, as Murchison has pointed out, is based on a knowledge of these facts, and consists in preventing dogs from feeding on offal, or frequenting slaughter-houses, and in thoroughly boiling all "dog's meat;" further, the tapeworms generated in dogs should be destroyed by periodically physicking the dogs, and burying or burning their excreta. These measures are of national importance in countries, such as

¹ See Case I., p. 17, in Dr. Bright's work on Abdominal Tumors.

Iceland, where the sheep-dog nightly occupies the same room as his master. In Iceland, hydatids are the cause of one-seventh of the human mortality.

The *surgical treatment* consists either in evacuating the fluid contents of the cyst by a fine trocar and canula, or an aspirating needle; or in the evacuation of the whole of the contents of the cyst by a large and free opening.

Puncture.—The evacuation of the fluid of hydatid, as well as of simple cysts of the liver, has long been recommended and practised by English physicians and surgeons,¹ several of whom have pointed out that when a fine trocar and canula are used, and care is exercised on withdrawing the canula to keep the abdominal parietes gently pressed back against the liver, there is no necessity to wait for adhesions between the cyst-wall and the abdominal parietes before resorting to operation. Experience has shown that, in a large proportion of cases, the removal of the thin and limpid liquid of a hydatid tumor is sufficient to destroy both the parent and daughter cysts. Moreover, the safety and efficiency of the operation are amply proved. The experience of this treatment at the Middlesex Hospital over a period of many years, has been highly successful, as the cases recorded by Murchison and Greenhow show. Greenhow has put on record two cases of tumor of large capacity, from which 110 and 148 fluidounces were drawn off in this way, and in each of which a cure was obtained. I can from my own experience bear testimony to the efficiency of simple tapping with a small aspirating trocar and canula: in three cases a single tapping, and in another a single repetition, effected what seemed to be a perfect cure. The operation should be performed in all cases in which the tumor is visibly increasing: the inducements to evacuate the contents under these circumstances are twofold, viz., (1) to prevent the risks of rupture, either spontaneous or traumatic; and (2) to relieve discomfort, and to obviate the injurious effects of pressure and weight upon neighboring organs.

The mode of operating is as follows: The patient being in the recumbent position in bed, a puncture into the most prominent part of the cyst is made with a fine trocar and canula, connected or not with an exhausting syringe, or aspirator. The fluid is thus evacuated, but before withdrawing the canula the surgeon must make sure that there is nothing plugging its opening and preventing the escape of some remaining fluid; this is done by simply moving the end of the canula within the cyst, if the aspirator is being used, or by passing a fine wire through the canula, if it is not connected with an aspirator or exhausting syringe. On withdrawing the canula, the punctured parietes are pressed against the cyst so as to avoid dragging them apart, and thereby allowing the fluid in the canula to drop into the peritoneal cavity. The puncture is covered with a piece of absorbent cotton-wool and collodion; a large soft compress of cotton-wool is placed upon the liver, and a flannel bandage is applied over the compress and around the trunk. Strapping should not be used: it is less comfortable to the patient, and, by not yielding to the respiratory movement and to the constantly varying size of the abdomen, drags upon the skin and exerts too much pressure. When employed merely to retain a thick, elastic layer of cotton-wool, there is less objection to it. The patient should be kept in the recumbent posture for thirty-six hours, and all manipulation on the part of the medical attendant, and all unnecessary movements of the chest and abdomen on the part of the patient, should be strictly forbidden. An anæsthetic is rarely needed, and is best avoided, lest vomiting should be excited. If the patient is very sensitive to

¹ Hawkins, Med.-Chir. Trans., vol. xviii. pp. 167-171; Brodie, *ibid.*, p. 119; Bright, *op. cit.*, p. 42; Budd, Med. Times and Gazette, May 19. 1860, p. 494; Murchison, Diseases of the Liver; Greenhow, Trans. Path. Soc. Lond., vol. xvii. p. 127.

pain, or very nervous, the ether spray may be locally applied. There is rarely any subsequent pain or uneasiness, but if there is, an opiate should be given. As a rule, the evacuation of the fluid is followed by immediate relief from the sensations of weight and tension; but in many instances, after a week or ten days, the liver enlarges again, owing to some inflammatory effusion around and within the cyst-wall. This enlargement may increase for a week or ten days; but afterwards the inflammatory products are slowly absorbed, so that swelling should not lead to a hasty repetition of the tapping. The inflammatory changes are indicated by the character of the fluid which is withdrawn if a second puncture is made—this fluid being of a higher specific gravity, turbid, and containing albumen, and even a tinge of blood. It is no proof of an unsuccessful result of tapping, that some degree of fulness remains for many months in the situation of the tumor, because, as the operation, though it kills the hydatid, does not remove the parent-cyst and secondary vesicles, time must be allowed for them to undergo atrophy.

It sometimes happens that the sac refills with fluid, and in this case the secondary enlargement does not subsequently diminish, but on the contrary increases until the swelling again feels elastic or fluctuates. Under these circumstances a repetition of the tapping is requisite.

The dangers of tapping are (1) acute peritonitis, from the escape of some of the hydatid fluid into the peritoneum, and (2) suppuration of the cyst. An altogether exceptional risk is illustrated by a case recorded by Mr. Bryant,¹ in which sudden death followed the puncture of a single hydatid cyst, owing to the perforation of the trunk of the portal vein which had been displaced forwards and upwards by the tumor. Blood escaped into the cyst and peritoneum; but death was attributed not to the hemorrhage, but to the escape of some of the hydatid fluid into the portal vein.

With due care on the part of the surgeon and absolute quietness on the part of the patient, these risks are not great, and there are several cases on record to prove that peritonitis is not by any means necessarily set up by the escape of the hydatid fluid into the peritoneal cavity.²

It is quite unnecessary to wait for the formation of adhesions between the cyst and parietal peritoneum; nor should any steps be taken to induce them. The elasticity of the walls is sufficient to close the opening made by a small instrument. No irritating substance, such as alcohol or iodine, should be injected into the cyst after withdrawing the liquid; it is not requisite for the purpose of killing the parasite, and it is prone to excite dangerous inflammation in the cyst. In some cases in which puncture has seemed to cure the tumor, the patients have returned after months or years with a cyst as large as ever, and in some instances in a state of suppuration. It is undeniable that in some of these cases the original cyst has refilled; but it is equally certain that in others the recurrent tumor is due to the growth of a fresh cyst, which may or may not have existed in a small and unrecognized form at the time of the operation.

Puncture is not contra-indicated either by the great size of the tumor, or by the presence of some amount of irritation in it. The latter condition suggests a risk of suppuration, but good recoveries have followed puncture in both classes of cases.³

There are two conditions however in which a free incision should certainly be employed instead of puncture, namely: (1) when the cyst's contents are very largely composed of daughter-cysts instead of fluid, and, (2) when

¹ Trans. Clinical Society, vol. xi. p. 230.

² See paper by Dr. Fagge, *Med.-Chir. Trans.*, vol. liv.; and paper by Dr. Dumn, *Trans. Clin. Soc.*, vol. vi.

³ Greenhow, *loc. cit.*, vol. xviii.; Duffin, *loc. cit.* vol. vi.

suppuration has already set in. The presence of a large proportion of secondary cysts cannot with certainty be foretold; but perhaps the rapid growth of the tumor, pain whilst the tumor is yet small, and absence of fluctuation and thrill, are the most suggestive symptoms of this condition. If, on tapping, the quantity of liquid which escapes is much less than the size of the cyst would lead one to expect, the inference is that the daughter-

CASES OF HYDATID TUMOR OF LIVER TREATED

Year.	Name.	Age.	Sex.	Married or single.	History.	State on admission.
1870	E. C.	29	F.	Marr'd	.....	Multiple hydatids of peritoneum.
1871	C. M.	45	M.	Single	Till 1857 enjoyed good health; he then first discovered a tumor over the liver. Two years ago he noticed another tumor over umbilical region; no pain in either tumor.	Multiple hydatids of liver and omentum.
1871	T. C.	29	M.	Marr'd	.....	Hydatids of liver; hepatic dulness measured $9\frac{1}{2}$ inches.
1874	E. J.	29	F.	Marr'd	.....	Admitted with all the signs of pleurisy with effusion on the right side; the liver enlarged and pushed downwards. Subsequently pleuritic friction was heard on the right side, and the liver dulness extended. Vomiting and pain in abdomen followed. Shortly after this a visible bulging was noticed over liver. The liver dulness increased in every direction.
1875	A. H.	23	F.	Single	Patient has had a dull pain in region of umbilicus for 6 weeks. Her attention was called to it by a swelling in that region four days ago.	Hydatid of liver. Suppurating and discharging at umbilicus.
1876	C. T.	49	F.	Marr'd	7 years ago, when stooping, felt sudden pain in abdomen. She afterwards noticed a lump the size of a hen's egg. 5 years ago the tumor was tapped; 6 months ago the swelling began to enlarge again.	A prominence seen in the left epigastric region, corresponding to the left lobe of the liver. The swelling was smooth and elastic; dull on percussion.
1877	J. M.	35	M.	Single	Patient has had pain in the right side for 3 years. There was bulging in the right mid-axillary line. At Royal Hospital, City Road, a small puncture was made and some purulent fluid withdrawn; subsequently paracentesis was performed in 8th space, and some fluid containing cyst-walls removed.	.....

cysts are numerous, and suppuration may be expected. The state of health of the patient, the size of the cyst, the admission of air, inquisitive manipulation after tapping, and any roughness or injudicious movement, may excite suppuration; but of all conditions the two in which puncture is most likely to be followed by the formation of pus, are, when the tumor is of large size, and when there is a large proportion of secondary cysts.

IN THE MIDDLESEX HOSPITAL SINCE 1870.

Treatment, with dates.	Result.	Stay in hospital.	Post-mortem report.
.....	Discharged at own request.	8 days.	
.....	Relieved.	12 days.	
.....	Discharged at own request.	51 days.	
The girth of the abdomen having increased, the tumor was tapped on April 9, and 46 oz. of purulent fluid withdrawn, containing a number of hydatid cysts. A gum-elastic catheter was introduced, and the cavity washed out. The canula was retained. The liver after tapping returned almost to its normal size. April 19, the tube was removed, and matter allowed to drain through the wound. The cavity was washed out daily. The opening closed in 24 hours after the tube was removed.	Convalescent.	72 days.	
.....	Recovered.	130 d'ys.	
Sept. 7. The tumor was tapped and 24½ oz. of straw-colored fluid withdrawn. The fluid was found to contain cholesterine scales, fat globules, and albumen.	Discharged at own request. Much improved.	27 days.	
On admission a small incision was made over seat of puncture of a few days ago, and a large trocar and canula introduced. Nothing escaped through this, and a probe when introduced was found to enter a large smooth cavity, a depth of about eight inches. When the probe was withdrawn, opaque and transparent membranous shreds of a jelly-like consistency escaped, but not sufficiently fast, so a large incision was made, and the cavity cleared out and washed out. A drainage-tube was inserted. The cavity was washed out daily, with increasingly less discharge. He left the hospital with a catheter in, but on showing himself again on Jan. 7, 1878, the tube had then been out for a fortnight, and the opening had quite closed with a depressed cicatrix. The bulging in the side had entirely disappeared.	Cured.	77 days.	

CASES OF HYDATID TUMOR OF LIVER TREATED

Year.	Name.	Age.	Sex.	Married or single.	History.	State on admission.
1877	C. F.	58	M.	Marr'd	.....	The liver dulness began at lower border of 6th rib in front and 9th behind, and extended vertically $7\frac{1}{2}$ inches; in the middle line it reached to the umbilicus. Above, its upper border corresponded to xiphoid cartilage, and on left it reached nearly to mammary line. An inch above the umbilicus, to the right of the middle line, was an ovoid swelling, tender and ill-defined, measuring about 3 inches upwards and outwards, reaching to within an inch of first floating rib. The swelling was elastic and fluctuating.
1878	W. S.	38	M.	Marr'd	Ten weeks ago was taken with severe twisting pains in abdomen.	The abdomen was very tense and tender, especially in epigastric and hypochondriac regions. May 11, the abdomen was very tense and dull on percussion, right across. The swelling was semi-fluctuating. May 22, there was a distinct prominence in the epigastric region.
1879	S. M.	26	F.	Single	Four years ago was ill for 14 days with sickness, loss of appetite, and headache; not jaundiced; 6 days ago was attacked with vomiting; no abdominal pain; at the same time she noticed her eyes were yellow and urine high-colored.	Liver dulness began in mammary line at 5th rib, in axillary line at 5th interspace. It extended to costal arch below, and measured 5 inches in nipple line, and $3\frac{1}{2}$ in parasternal line. Abdomen was somewhat distended.
1879	W. H.	58	M.	Marr'd	24 years ago had jaundice. After he was well of that, a small lump formed on his right side; this disappeared, but came out again in lower part of right back; this burst and left an open, non-discharging wound for six months. 12 years ago he had a small tumor the size of a horse-bean in the lower part of the right side of chest, which has gradually increased till now. 4 years ago he felt as if something had given way inside him, followed by sickness and diarrhoea. This was followed by hepatic tenderness, and a month after he was jaundiced.	The liver dulness began above at nipple level, and extended vertically downwards about 7 inches. Just to the left of the middle line was an elastic, rounded tumor, with ill-defined edges; it moved with respiration; it seemed to protrude from under left costal arch. The right border of the tumor reached to the middle line. It measured transversely $5\frac{1}{8}$ inches, and vertically $4\frac{1}{2}$ inches; no fluctuation could be obtained.

IN THE MIDDLESEX HOSPITAL.—*Continued.*

Treatment, with dates.	Result.	Stay in hospital.	Post-mortem report.
Oct. 18. Tumor was tapped, and $\frac{1}{2}$ oz. of blood-stained and somewhat milky fluid drawn off, containing flakes and granular-looking shreds of membrane. On the 23d he got jaundice. The tumor was then again aspirated, and only 3 oz. of fluid withdrawn. It was then freely incised, and a quantity of fluid with collapsed cysts escaped. A drainage-tube was inserted. On the 25th the tube was removed, and the wound left to heal, it having been washed out daily. By Nov. 15 the wound had healed, but the tumor had reformed. Nov. 17, the tumor was again opened, and only a small quantity of sanguineous fluid withdrawn. The discharge from the wound then became very free and in character that of pus. He had also developed a cough with offensive sputum. The discharge gradually became more profuse.	Death.	54 days.	The right lobe of the liver was found to be almost entirely replaced by 3 large cysts; 1 emptied by paracentesis; another fill'd with daughter-cysts; a third was suppurating, and had made its way into the lower lobe of right lung. Kidneys granular.
May 24. A trocar was inserted into tumor, and only a small quantity of blood withdrawn. The abdomen continued to swell, and vomiting set in after this; also œdema of both legs and hands.	Death.	41 days.	The right lobe of the liver was almost entirely occupied by a large suppurating hydatid cyst which had perforated through the diaphragm into the right pleura, causing empyema and compression of the lungs.
July 4. An exploratory puncture was made with a hypodermic syringe 2 inches below the scapula, and a few drops of pale, clear fluid and air withdrawn. July 14. The swelling was aspirated between the 9th and 10th ribs. Then a free incision was made, and 43 oz. of pus and gelatinous, brownish-colored membrane let out. A drainage-tube was inserted. July 29. The wound was irrigated with a solution of tincture of iodine 3j-Oj.	Death.	80 days.	There was a fistula in 9th interspace leading to a nearly empty hydatid cyst in right lobe of liver. There were abscesses elsewhere in liver. A quantity of semi-inspissated pus in right pleura. Compression of lung with lines of interlobular pneumonia.
Sept. 24. The tumor was explored with a fine trocar and canula. Some broken-down granular material with large cells containing nuclei escaped. Oct. 2. The tumor was again aspirated, and small pieces of semi-transparent membrane were removed. Oct. 4. The patient anesthetized, and a small incision was made in the seat of the old puncture, and a curved trocar and canula inserted into tumor. On withdrawing the trocar some unbroken hydatid cysts and pieces of membrane came away. The canula was left in; the next day tubing replaced the canula, and the cavity was washed out with a solution of sulphurous acid; he, however, shortly afterwards developed peritonitis.	Death.	31 days.	Deep jaundice; fistulous opening in right hypochondrium; liver adherent to parietes. Abscess beneath right lobe, and numerous small cysts full of pus and shreds of membrane in the left lobe. Other small cysts scattered in liver. Gall-bladder and main duct distended with clear fluid. Kidneys granular and bile-stained.

CASES OF HYDATID TUMOR OF LIVER TREATED

Year.	Name.	Age.	Sex.	Married or single.	History.	State on admission.
1880	C. A.	39	F.	Marr'd	14 years ago had a lump in her right side. 10 years ago was operated on for hydatid of liver in King's Coll. Hospital, and again the following year. Six years ago was operated on at St. Bartholomew's.	The right hypochondriac region occupied by a prominent swelling reaching to umbilicus; $2\frac{1}{2}$ inches below xiphoid was a sinus discharging pus. The tumor moved with respiration, was firm, non-elastic, and non-adherent to skin.
1881	J. T.	29	M.	Single	Five years ago had some pain over liver. Had not noticed any swelling. Was at work till 3 days ago.	There was considerable bulging in right hypochondrium. The swelling moved with respiration. The liver dullness began at nipple level, and extended to umbilicus. The liver dullness extended across the middle line to left hypochondrium.
1881	J. P.	41	M.	Single	17 years ago had jaundice in India. At that time he noticed a swelling in epigastrium which remained painless till 9 months ago.	The liver dullness commenced at 5th rib in mammary line, and extended to an inch off the umbilicus; on the left side it merged on splenic dullness. It measured 8 inches vertically. There was a large oval swelling in epigastrium. It moved with respiration; a faint wave could be obtained at upper part. The tumor was firm, hard, and a little irregular.
1881	A. C.	14	M.	Single	Patient has had pain in his right side for about a month.	Liver dullness commenced at 6th rib, and reached to half an inch from umbilicus. The dullness extended across to the left side, verging into cardiac. The swelling occupied the epigastrium and right and left hypochondriac regions, the greatest prominence being just below costal margin. Tumor moved with respiration; firm, and non-fluctuating.
1881	A. H.	29	F.	Single	7 years ago was treated for hydatid of liver. 6 weeks ago felt sharp pain in right hypochondriac region.	The liver did not extend below the ribs, but there was a distinct bulging on the left side in the lower axillary and infra-mammary region, which she had noticed for three years.
1882	E. H.	29	F.	Single	12 months ago noticed that her ribs began to grow out after a fall; a swelling formed, and has gradually increased in size.	Liver dullness normal. The left hypochondriac region was occupied by a globular swelling. It was elastic, and moved with respiration. Its area of dullness was continuous on the left side with that of the spleen, and on the right with that of the liver. The lower edge well-defined, and could be felt.
1882	M. L.	32	F.	Marr'd	2 years gradually increasing swelling in hepatic region.	Liver dullness increased downwards on right of median line. There was a globular outline to swelling.

Free Incision.—A certain proportion of failures must be expected to follow simple puncture. Murchison's table shows that out of 46 cases in which the operation of simple tapping was performed, 35 appear to have been quite successful. In 10 cases the operation was followed by suppuration, necessitating a free opening, and in these, 8 patients recovered and 2 died. In neither of the two fatal cases did death seem to be caused, or indeed hastened, by the operation. In one case the patient succumbed to peritonitis within twenty-four hours after the puncture. Dr. John Harley,¹ who advocates a large and

¹ Med.-Chir. Trans., 1866, vol. xl. Dr. Harley has again urged the value of a free opening, and described his method of procedure, in a paper in the 12th vol. of St. Thomas's Hosp. Reports, 1883.

IN THE MIDDLESEX HOSPITAL.—*Concluded.*

Treatment, with dates.	Result.	Stay in hospital.	Post-mortem report.
Tumor incised. Cavity washed out with carbolic acid through wound, coming out through fistula. Cavity washed out daily.	Cured.	32 days.	
Feb. 2. Tumor tapped, half an inch below costal cartilages, and 27 oz. of clear, watery fluid removed, which contained some cysts.	Cured.	56 days.	
June 3. Tumor tapped, only pure blood evacuated. During his stay in the hospital the liver dulness remained the same. The tumor had become harder.	Not improved.	71 days.	
July 5. Tumor tapped; needle first entered solid substance and then the cyst, and 25 oz. of clear watery fluid drawn off. The tumor shrank visibly. July 9. Swelling again appeared. Aug. 10. Tumor tapped; 1½ pints clear, watery fluid drawn off.	Relieved.	70 days.	
Nov. 9. Tumor aspirated in most prominent part, and 46 oz. of clear fluid withdrawn.	Cured.	10 days.	
Aug. 31. A hypodermic syringe was thrust into the most prominent part of the swelling, but no fluid was withdrawn. The tumor from that day gradually got less prominent, although the area of dulness remained the same.	Discharged at own request.	22 days.	
Tapped twice with aspirator, 25 and 18 oz. being drawn off. Fluid slightly turbid, contained well-marked echinococcus hooklets.	Left without trace of tumor.	26 days.	

permanent opening in preference to a small puncture, gives a mortality of 10 out of 35 cases of puncture; but Murchison has pointed out that Dr. Harley's table "throws an illegitimate discredit" upon the operation in question.¹ A former student at the Middlesex Hospital—Dr. Mortimer Balding—in his graduation thesis for the degree of Doctor of Medicine, of Cambridge, 1880, collected 267 cases of hydatid cyst of the liver; of these the character of the fluid at the first tapping is given in 155. Out of these 155 cases the fluid was clear in 106, and in 49 it was more or less thick, purulent, or tinged with bile. Out of the 106 cases in which clear fluid was drawn off at the

¹ Murchison, *Diseases of the Liver*, 1st ed., p. 112.

first puncture, there were 86 cures, 17 deaths, and 3 in which the results are unknown. Moreover, there is no evidence that suppuration ever took place in 71 of the 106 cases, and of these 71 cases 58 were cures, 11 deaths, and 2 unknown as to results. In the 49 cases in which the fluid was not clear on the first puncture, 26 patients were cured, and 20 died, the results in 3 cases being unknown.

The inference is, that if the fluid is not quite clear at the first puncture, if suppuration sets in after the first puncture, or if no improvement follows puncture when the contents of the cyst consist largely of daughter-cysts, the proper plan of treatment is, either to introduce a very large trocar and canula, and leave the canula in, or, what is still better, to make a deliberate incision into the cyst, and stitch the edges of the cyst or liver to the edges of the parietal wound. To delay operating in one of these ways, after pus has fairly formed, is to court disaster by long and exhausting illness, if not by early death. The medical attendant should, therefore, carefully watch for the signs of suppuration.

In making an incision we need not fear wounding a non-adherent peritoneum. The operation should be thus performed: an incision should be made through the abdominal parietes over the most prominent part of the cyst, until the liver-capsule is reached, all bleeding from the cut surfaces being arrested, however, before the peritoneum is opened; a trocar and canula should then be introduced into the cyst, and all the fluid drawn off, taking care that none of it escapes into the peritoneal cavity; this can be insured by having a long canula, or by packing sponges around it, before withdrawing the trocar. Next, an incision with a narrow-bladed bistoury should be made into the cyst, using the canula as a guide. If adhesions have not formed between the cyst and the parietes, care must be taken to seize and draw forwards the edges of the incision into the liver-cyst, and they should be stitched by continuous suture to the edges of the incision in the abdominal parietes. Sir Joseph Fayrer has devised a grooved canula for opening liver-abscesses, which is well adapted for hydatid cysts; the canula is of medium size, and would empty the cyst of fluid and small vesicles, and its groove would then serve as a guide for the bistoury. After emptying it of its contents, the cyst should be washed out with a weak solution of iodine, Condyl's fluid, salicylic acid, or some other antiseptic; a drainage-tube should be inserted, and the opening covered with boracic charpie, or cotton-wool, and over that a layer of carded oakum. Subsequent daily dressings and irrigation will be required for a longer or shorter time, according to the amount and character of the discharge. I have opened hydatid cysts of the liver in this manner on five or six occasions, and have been surprised at the slight amount of bleeding which has followed incisions, deep and wide through the liver tissue, made in order to fully lay open the interior of the cyst; and even when hemorrhage has, for the moment, been free, it has soon stopped upon using gentle pressure. A source of danger from bleeding lies, however, in rough attempts to tear out the parent-cyst. Such an attempt should never be made. Bright¹ relates a case, in which, the cyst having opened and discharged spontaneously just below the umbilicus, an effort was made to pull away the cyst-wall. The next day severe hemorrhage set in, and at the post-mortem examination an open hepatic vein was found, from which the bleeding had occurred. Though it is right to remove at once all the secondary cysts from its interior, the parent membrane should be left to become loosened, or to slough, and then large masses of it will escape in the subsequent dressings.

The chief dangers after free incision, are exhaustion from protracted dis-

¹ Op. cit., p. 50.

charge, pyæmia, and secondary abscesses. The best security against these contingencies is early operation. That the mortality hitherto has been nearly fifty per cent., and that many of the successful cases have recovered only after a long and exhausting illness, is largely due to hesitation and procrastination before having recourse to the operation. The preceding table (page 646) contains most, if not absolutely all, of the cases which have been under treatment in the Middlesex Hospital, since the termination of the late Dr. Murchison's connection with it. The cases therein contained show the advantage of operative treatment, by either simple tapping or incision. When the treatment has failed, it has been because failure of tapping has not been followed up by free incision; or because a second or third, deeper-placed cyst has burst into the peritoneum or lung; or, finally, because the cyst has existed a very long time, and jaundice and its other ill effects have been produced before the case has come under treatment at the hospital.

The influence of Cruveilhier,¹ Récamier,² Bégin,³ and others, who used to insist on the necessity of adhesions before operating upon hydatid cysts and abscesses of the liver, and who resorted to tedious and harmful methods to obtain these adhesions, did much to retard the adoption of a better line of treatment. The same fears do not trouble the surgeon of to-day; and it is much to be regretted that the remarks made by Dr. Wm. Thomson, in 1841, in his learned and practical treatise on "Diseases of the Liver and Biliary Passages," were not earlier acted upon by surgeons generally. Dr. Thomson says:⁴ "The observations already made in respect to opening of abscesses, seem to show that the apprehensions about exploratory punctures of aqueous or hydatid cysts of the liver are exaggerated; and perhaps, also, to suggest the expediency of an operation being performed in this class of cases at an earlier period than has heretofore been usually practised."

Treatment by Electrolysis.—Dr. Hilton Fagge and Mr. Durham employed electrolysis in the treatment of eight cases of hydatid tumor of the liver.⁵ Two needles were connected with the negative pole of a modified Daniell's battery of ten cells; the positive pole was connected with a moistened sponge. The needles were introduced into the cyst, and the sponge was applied to the surface of the abdomen. The current was continued for a period varying from ten to twenty minutes at a time; and the treatment was continued over a period varying from two to four or five weeks. Besides the eight cases in Fagge's list, one other, recorded by Playfair,⁶ should be added; all the nine patients did well, and recovered; but it must be added, that the tumors were small, and in young subjects. Dr. Fagge suggested two alternatives of the *modus operandi* of electrolysis, (1) leakage from the cyst into the peritoneum or elsewhere, (2) the direct action of the electrolytic current. In four out of the eight cases observed by Dr. Fagge, fluid did leak into the peritoneal cavity, and once it leaked into the pleura. In two, if not in three cases, leakage, it is presumed, did not occur. The operation was generally followed by slight febrile symptoms and some pain; but these symptoms usually passed away in a few days.

It has been already stated that hydatids may occur in any part or organ of the body; and may originate in, invade, or encroach upon, any abdominal organ. Wherever one exists it will indicate its presence, if at all, first by the occurrence of swelling in the region of the abdomen occupied by the organ

¹ Dict. de Méd. et Chir. Prat., Art. Acéphalocystes.

² Rev. Méd., tome iii. p. 436. 1827.

³ Journ. Hebdom., tome i. p. 417. 1830.

⁴ Op. cit., p. 244.

⁵ Med.-Chir. Trans., vol. liv.

⁶ Ibid.

affected, and then by interfering by its pressure with the functions of the particular organ, or of some other important structure in its neighborhood. Bearing these facts in mind, what has been said respecting hydatids of the liver holds good of similar tumors of the kidney, spleen, omentum, etc. I shall therefore dismiss the subject of hydatids of the other abdominal and pelvic organs in a very few words.

HYDATIDS OF THE GALL-BLADDER.—Walther says¹ that he once met with hydatids in the cavity of the gall-bladder; but he regarded this as an unique morbid condition.

HYDATIDS OF THE SPLEEN.—The recognition of the hydatid nature of the tumor will rest upon the same evidence as in hydatid of the liver; but the diagnosis as to whether in any particular case the cyst is in the spleen, left lobe of the liver, or left kidney, will be based on the same objective symptoms as in cases of other swellings in the left hypochondrium. This is often excessively difficult, and in the cases in which the fluid contained in the cyst presents cholesterine, and is found to give the play of colors with nitric acid suggesting the presence of bile,² confusion is almost sure to be caused. Generally, however, a hydatid tumor of the spleen extends too far back in the left hypochondrium and left loin to be mistaken for a growth in the left lobe of the liver. The absence of all renal or vesical irritation would help to exclude the kidney, but would not absolutely do so.

The *treatment* should be based on exactly the same principles as have been described under the heading of hydatids of the liver.³

HYDATIDS OF THE KIDNEY.—In some cases no symptoms exist, in others, besides the presence of a renal tumor, there may be attacks of renal colic, followed by the discharge of hydatid vesicles *per urethram*. Hydatid cysts of the liver, it should be remembered, have sometimes discharged themselves into the pelvis of the kidney. If a renal cyst enlarges it is apt to be mistaken for an ovarian cyst, and patients have been operated upon under this erroneous diagnosis.

A renal hydatid cyst may burst into the pelvis of the kidney, or into the intestine, or peritoneum, or lung. Suppuration may occur either before or after a puncture has been made, and then fever and lumbar pain set in as a rule.

The *diagnosis* is made certain if, when the history and situation of a tumor suggest the kidney as its seat, hydatid vesicles are passed by the urethra.

The *prognosis and treatment* are the same as in hydatid of the liver—with this reservation, however, as respects prognosis: that hydatids of the kidney, as of the spleen, are very often secondary to hydatids of the liver.

HYDATIDS OF MESENTERY AND OMENTUM.—Hydatid tumor in either of these parts occurs occasionally, either alone or in conjunction with hydatid of the liver.

A woman, aged 45, who had jumped out of a window, was admitted into the Middlesex Hospital under my care, with a number of fractured bones. She died, and at the post-mortem examination there was found a rounded hydatid tumor, the size of a small

¹ Annot. Academ.

² See paper by Habershon, Guy's Hosp. Rep., 3d series, vol. xviii. p. 384.

³ For details of cases of hydatid of the spleen, see Bright, Clinical Memoirs on Abdominal Tumors; Habershon and Hilton Fagge, Guy's Hospital Reports, 3d ser., vols. xiv. and xviii.; Bristowe, St. Thomas's Hospital Reports.

melon, in the substance of the mesentery. The capsule of the cyst was of dense, cartilaginous hardness, and the contents were a semi-fluid, caseous mass, of a pale-yellow color. The walls of the cyst were covered internally with calcareous plates. This was a case of spontaneous recovery of a hydatid of the mesentery.

Dr. Wickham Legg¹ has recorded a case of hydatid cyst within the omentum. The cyst was full of daughter-cysts, and was adherent to the sigmoid flexure of the colon; there were, besides, three cysts in the liver, and another, the size of a child's head, between the rectum and bladder. Death was caused by prolonged jaundice due to pressure of one of the hepatic cysts upon the hepatic duct.

Murchison² reported two cases in which numerous hydatid cysts had grown in the mesentery, omentum, and other parts of the peritoneum. In one case certainly, and in the other doubtfully, the disease commenced in the liver.

Hydatid tumors in these processes of the peritoneum, if large enough to be detected, present smooth, elastic, painless, movable swellings. If they are numerous and growing, or if single and of very great size, there will be paroxysmal attacks of abdominal pain, vomiting, dyspnoea, and faintness; and possibly ascites and other evidences of intra-abdominal pressure. The tumor will be lobulated or uniform, according as there are several cysts, or only one cyst.

Tapping, or the removal of the cysts by laparotomy, must be resorted to for relief or cure. Though it may be found impossible to remove all the cysts when multiple, relief from distension will be afforded by puncture; and life will be prolonged, and the patient temporarily improved, by the evacuation of several of them.³

HYDATIDS OF THE ABDOMINAL PARIETES.—Hydatids occur in the subcutaneous areolar tissue, in the muscles, and in the cellular tissue between and beneath the muscles of the abdominal walls.

Mr. Bryant⁴ has recorded a case of an enormous tumor beneath the muscles, but apparently outside the peritoneum, which had been growing fourteen years, and had throughout been regarded as an ovarian cyst. It was tapped in the eighth year of its existence, when seven pints of thin fluid were drawn off. Subsequently it attained the size of a pregnant womb at full time, and a second cyst, the size of half an orange, developed beneath the skin, midway between the pubes and the umbilicus. Mr. Bryant removed the smaller, and laid open the larger cyst, from which many quarts of hydatids and fluid escaped. The edges of the wound in the cyst were stitched to the edges of the external wound by five or six sutures, an opening three inches in length being left. The patient had quite recovered in sixteen weeks. Mr. Bryant remarks, that this large tumor, when kneaded, gave rise to a special and peculiar sensation, due to the rolling and pressing together of the immense and closely packed mass of secondary (daughter) cysts, and he thinks that this might help to indicate the nature of a similar case.

HYDATIDS BETWEEN THE BLADDER AND THE RECTUM.—Several cases of hydatid tumor in this situation are recorded. Dr. Legg's case above alluded to, and cases recorded by Dr. Bright, are good instances.

The usual symptoms caused by hydatids in this situation are difficulty in defecating and micturating, with pain in the penis, groins, and over the lower part of the abdomen, and oedema of one or both of the lower limbs. A smooth, elastic swelling will in all probability be felt *per anum*. In a

¹ Trans. Path. Soc. Lond., vol. xxv. p. 160.

³ Ibid., vol. xxiii. p. 128.

² Ibid., vol. xxiii. p. 126 *et seq.*

⁴ Guy's Hosp. Rep., 3d ser., vol. xiv., p. 235.

case recorded by Mr. Bryant, the post-mortem examination of which I made with my friend Mr. De'Ath, of Buckingham, the bladder was pushed quite high up out of the pelvis, and in the direction of the left hypochondrium. There had been long-standing urinary troubles, and retention at last became complete. Dr. Bright¹ gives two cases of hydatid in this situation, in one of which there was incontinence of urine, and a tumor, giving the appearance of vesical distension, presented itself above the pubes, and flattened the otherwise unaltered bladder.

When discovered during life, as they most likely will be owing to the symptoms they excite, these cysts should be evacuated by puncture or incision, if they cause inconvenience or distress. In a young woman under my charge, there was a large elastic swelling between the rectum and the uterus and vagina, causing much local and constitutional disturbance. A quantity of fluid was withdrawn by a puncture with a trocar and canula, passed into the cyst through the vaginal wall. Benefit was immediate, and the cure apparently permanent, for on readmission for another cause a year afterwards, there had been no reaccumulation.

CYSTS OF THE ABDOMINAL VISCERA.

SIMPLE, WATERY, OR SEROUS CYSTS OF THE LIVER.—These cysts occur either in the substance of the liver or just beneath its peritoneal covering. They may be either single or multiple, simple or multilocular, and may originate either by the dilatation of a biliary duct, or possibly by the expansion of a hepatic cell; or again by a new development altogether. Though not uncommonly existing of a small size, they sometimes attain very large dimensions, and encroach upon the diaphragm and surrounding abdominal organs. Generally they displace the intestines backwards, and therefore when they have grown so as to nearly fill the abdomen, and when their course and clinical history are not well known, they are liable to be mistaken for ovarian cysts. This mistake and the reasons for it are well illustrated in a case recorded by Dr. Ward Cousins.²

The inner surface of these cysts exhibits the general characters of serous membrane, and the outer surface, when not imbedded in the substance of the liver, is covered with a layer of condensed cellular tissue of greater or less thickness. They contain a limpid, saline fluid, differing from hydatid fluid by being coagulable by heat, alcohol, and acids. They grow slowly and painlessly, until by their great size they press upon important structures or organs. Many pints of fluid, even two or three gallons, have been removed from some of these cysts, and when they have attained to this size they cannot be diagnosed from unilocular ovarian cysts except by close attention to their clinical history. When of much smaller size they move freely within the abdomen, are noticeable as being connected with the upper part of the abdominal cavity and as therefore growing downwards, and are sometimes spoken of as "floating tumors." Yet from renal tumors they may be distinguished by the fact that *right* renal swellings have the ascending colon in front and to the inner side of them, and that *left* renal swellings have the descending colon crossing their front surface, whereas these hepatic swellings are as a rule in front of the bowels. From hydatid cysts it is impossible to distinguish them except by the characters of the fluid which they contain. From a perusal of a number of cases collected and recorded by Mr. Caesar

¹ Op. cit., p. 40.

² Brit. Med. Journ., Dec. 5, 1874, p. 700.

Hawkins,¹ one is driven to the conclusion that most if not all those which were grouped by him as "aqueous encysted tumors" of the liver, were in reality simple hydatid cysts, that is, hydatid cysts with aqueous contents, and no daughter-vesicles. It must be remembered that in 1833, when this paper was published, the exact anatomy of a hydatid cyst, and the chemical and microscopical characters of hydatid fluid, were not as well known as they are now. Prof. Gross² removed from a delicate woman, aged twenty-three, nearly a gallon and a half of fluid as clear as spring water. No recurrence followed. When an aqueous or simple serous cyst is not wholly inclosed by liver substance, but is projecting from its edge, or more or less pedunculated and hanging from its under surface,³ the distension of its walls may in time become so great as to lead to its rupture and to the discharge of its contents into the peritoneum; or after the formation of adhesions the cyst may spontaneously burst on the surface, or into a hollow viscus. Under certain circumstances the lining membrane of these cysts is apt to inflame and suppurate, so that they become converted into abscesses.

Treatment.—As soon as the cyst has attained to any uncomfortable size, or if there is any danger of its bursting into the peritoneum, it should be punctured in the same way as a hydatid cyst; and if it quickly refills it should be opened, and its edges should be stitched to the edges of the wound in the abdominal parietes. When a serous cyst attains a large size, it is prone to form anterior adhesions which may be difficult to break down, or which may bleed or ooze freely after separation; moreover, it cannot be determined in advance whether the cyst is pedunculated or in large part imbedded in the liver. These are reasons for not attempting complete extirpation. If, however, laparotomy has been performed on a mistaken diagnosis, and the cyst is easily separable from its adhesions, and fairly well protruded from the liver, there is no reason why, after it has been evacuated, the bulk of the cyst should not be cut away, and the remaining part stitched to the upper end of the abdominal wound.

My colleague, Mr. Hulke, has recorded a case of multiple dermoid cyst attached to the surface of the liver. It occurred in a woman who died of cancer of the uterus. Similar dermoid cysts were found connected with the ovary.

True cystic disease of the liver, in which the whole organ is more or less studded with small, if not minute, cysts, is generally found associated with similar disease (cystic degeneration) of the kidney. This form of cystic disease of the liver has no special surgical importance.

SIMPLE OR SEROUS CYSTS OF THE KIDNEY.—Distinct from that form of cystic distension of the whole organ which results from obstruction in the ureter, and which is commonly known as hydronephrosis; distinct also from that rare form of disease in which the whole kidney is converted into a mass of conglomerate cysts—some of which hold several ounces of fluid, the septa between which are mere relics of granular renal substance, and in which the cystic masses are eight or ten times the normal size of a kidney—and which always proves fatal; and distinct, too, from the cysts of small or microscopic size met with in great numbers in the "granular kidney," there are simple cysts frequently seen in the kidneys of elderly people, one or more of which may attain considerable size, and so constitute a disease of great importance. In our museum at the Middlesex Hospital, are some beautiful specimens of this form of cyst, though none of them are, perhaps, of a size to have formed

¹ Med.-Chir. Trans., vol. xviii.

² See Dr. Cousins's case, loc. cit.

³ System of Surgery, 6th ed., vol. ii. p. 634. 1882.

a noticeable tumor during life. In the Hunterian Museum there are also specimens, and the Transactions of the London Pathological Society contain some cases scattered through its volumes.

These simple cysts arise in the cortex of the organs, and project in relief from its surface, the rest of the kidney being healthy and functionally active. Sometimes, however, a communication is established between the cysts and one of the calyces of the kidney. The contents of the cysts are fluid, the fluid containing a small quantity of albumen and a little saline matter, but rarely, if ever, any urinary ingredients. Rokitsansky was never able to discover in them even a trace of urinous precipitates or concretions. Dr. Wm. Walter¹ records a case of cystic tumor in a floating kidney for which nephrectomy was performed. The cyst contained 10 ounces of a pale, straw-colored fluid, of specific gravity 1013, containing $\frac{2}{3}$ albumen, but no urine. The walls of the cyst were very thin and tense, and of transparent, bluish hue. In Mr. Caesar Hawkins's case of "Aqueous Encysted Tumor" of the kidney, the transparent fluid of the cyst contained no albumen, which suggests its possible hydatid nature; but Dr. Prout wrote of it, "the fluid is *serous*—I have not detected anything urinary in it."² If hemorrhage has taken place into the cyst-cavity, owing to the giving way of some bloodvessel in its walls, the fluid will have a sanguineous color and character. Moxon states, that very often these cysts contain a thick jelly-like matter, like thin glue, and at other times nearly solid, which resembles the colloid matter found in other parts of the body. The origin of these cysts is uncertain; possibly they arise from the conversion of the cellular layer in the Malpighian corpuscles into serous cysts, or from the dilatation of tubes or Malpighian capsules, or perhaps, from vacuolation of epithelium. But, however this may be, we know that cysts of different origin, and even of varying microscopical structure, may secrete fluid contents which are chemically and physically alike. Simple renal cysts commence insidiously, grow slowly, present themselves first in the loin, or in the lumbar area of the front of the belly, and may be so hard at first as to be mistaken for solid growths. As they increase, they gradually monopolize the greater part of the abdominal cavity, their point of attachment ceases to be even approximately ascertainable, and they may give rise to the idea of ovarian tumor when they occur in the female. Hemorrhage may take place into them; and cancer has been developed in their parietes. As they grow, they tend to spread out the renal substance, so that a good part of the kidney may be stretched in a thin layer over the attached part of the cyst-wall. Rokitsansky once found such a cyst of considerable size, and seated at the circumference of a kidney, inflamed and ruptured, its contents having escaped into the surrounding adipose tissue. The following case,³ which came under my own observation, affords an illustration of several of these points:—

A man aged 69, who had enjoyed good health till two and a half years previously, came under treatment for a swelling the size of a cricket-ball, situated to the left of, and somewhat below the umbilicus; it gave him no pain; he had had no injury; his urine was for a time albuminous, and once or twice contained a little blood; the tumor slowly increased, and was prominent, firm, globular, not fluctuating, and appeared more like a fibrous tumor of the abdominal wall than an intra-abdominal swelling. There was no dulness in the loin. Nine months afterwards (August, 1869), the tumor occupied the whole of the left half of the abdomen, and reached somewhat over to the right side of the median line; it fluctuated distinctly and in all parts, and was fairly movable in every direction, though the abdominal parietes were tightly stretched over it. During this and the two or three preceding months, the patient had had several attacks of syncope, which occurred generally

¹ Brit. Med. Journ., September 29, 1883.

² Med.-Chir. Trans., vol. xviii. p. 186.

³ Trans. Path. Soc. Lond., vol. xxii. p. 171.

after taking exertion, or after eating his midday meal. Eleven months subsequently (July, 1870), the tumor occupied nearly the whole abdomen, and projected forwards, and had the characters of an ovarian tumor. Fluctuation was distinct; emaciation and debility were extreme; there was no albumen, blood, or pus, in the urine. The man died on October 4, 1870, worn out by the distension and pressure of the tumor. He would not have done so, however, had I known then, as I do now, how to treat renal cysts. At the post-mortem examination, a large cyst was found springing from the left kidney, projecting forwards the peritoneum, and pushing the small intestines, which were quite free from the tumor, downwards into the right iliac and pelvic regions. The transverse and descending colon were adherent to the tumor by their meso-colon, and formed an arch over and towards its posterior aspect. The tail of the pancreas and lower end of the spleen were adherent to the back of the cyst. The left kidney occupied a nearly transverse position in the loin; its upper half was normal, but the rest was spread out in a thin layer over the base of the cyst. In this expanded portion was a second, small, transparent cyst, the size of a currant. The capsule of the kidney was continued over the cyst. The pelvis of the kidney was unaltered, excepting for the drag upon the calyces of that part of the kidney which was spread out over the cyst. The cyst weighed sixteen pounds, and measured, after it had been contracted in spirit, twenty-nine inches in its longitudinal and twenty-six inches in its transverse diameter. It was filled with a dirty-brown fluid, and with coffee-ground colored blood-clot. Some of the clot had been deposited in irregular strata, but some recent hemorrhage had also occurred. The cyst-wall varied in thickness, but averaged about one-eighth of an inch; large veins passed over its posterior surface, and branches of the renal artery and vein were traced into its substance. Two small nodules of medullary cancer were seen in the left kidney, and several in the lungs and liver; the right kidney was small, and contained several cysts varying in size from that of a pin's head to that of a pea, or larger. There was thus no difficulty in explaining the attacks of syncope during life; the large quantity of blood-clot in the cyst had clearly been derived from some of the branches of bloodvessels upon and in the cyst-wall. The cancer was a mere accidental coincidence in the case, and had probably been induced by the depraved state of health—the result of disturbed functional activity of the abdominal viscera—caused by the pressure of the tumor.

Dr. Bristowe¹ has recorded a case of doubtful origin, but which he regarded as a hemorrhagic cyst of the spleen, kidney, or peritoneum. It was cured by repeated tapping, and the evacuation, on the first occasion, of a gallon and a half of opaque, dark, reddish-brown fluid. This case was, most probably, one of simple cyst of the kidney, into which hemorrhage had occurred. The disease commenced with obscure abdominal symptoms, followed before long by an abdominal tumor, which rapidly increased until it formed a large, ovoid, somewhat irregular swelling, occupying the left side of the belly, and extending from the ribs above to the pubes below, and from the left loin to two inches or so to the right of the median line. The patient rapidly emaciated and got weaker, vomited, and suffered from intense abdominal pain coming on in paroxysms. His general aspect (he was a young man) was precisely that of a woman in the last stage of untreated ovarian dropsy, or of a child sinking from the effects of a malignant tumor of the kidney. The abdominal tumor was the only evidence of disease in the body. The large intestine did not appear to cross the front surface of the tumor.

The difficulty in the *diagnosis* of such cysts will be apparent from the reports of the above cases. The symptoms excited are merely those of pressure, and are, therefore, like the symptoms of other cystic swellings—hydatids, or cysts of other structures. The locality of the tumor in its earlier stages will somewhat aid the surgeon in correctly judging of the organ affected; but not even then in estimating precisely the character of the swelling. In Bristowe's case, in its symptoms, position, and cure by repeated tapplings, the tumor resembled some of those false cysts which are formed by adhesions after rupture of the kidney or liver, and which have been described in previous sec-

¹ Lancet, May 5, 1883 (case also previously published in St. Thomas's Hosp. Reports).

tions. My own case, in its early days, was most like one of solid inter-mural tumor; and afterwards, like Bristowe's, might have been, if in a woman, mistaken for one of ovarian disease. The relative position of bowel to ovarian cyst, as compared to that of bowel to renal tumor, would not have assisted to a differential diagnosis in either instance. Nor did the character of the urine. Bristowe, in the same number of the *Lancet*, records another case which shows the difficulty of diagnosis and somewhat resembles his first case. The second, however, on post-mortem examination, turned out to be one of round-celled sarcoma, growing from amongst the pelvic viscera, and containing a large, hemorrhagic cyst. The cyst was tapped five times, fluid of a reddish-brown color, alkaline reaction, and specific gravity 1024, being drawn off in quantities varying from seventy-four to one hundred and sixty-seven ounces. Thus the difficulties which surround the diagnosis of these very rare cysts are extremely great, for not only may they be mistaken for hydatids of the kidney, hydronephrosis and other tumors of the kidney, and perinephric fluid collections; but it is, moreover, almost impossible, after using every care in examination, to distinguish them, sometimes from solid tumors in the parietes, sometimes from hepatic or splenic cysts, or cysts of the omentum, mesentery, or pancreas, sometimes from malignant cystic tumors springing from the pelvis or elsewhere within the belly, and sometimes—indeed, generally, in their later stages—in the female, from ovarian cysts.

The *treatment* of these cysts is the same as the treatment of hydatid cysts of the kidney, and of hydronephrosis and pyonephrosis. As soon as they have attained such a size as to cause inconvenience, they should be tapped, and if they refill again and again, they should be cut down upon, either in the loin or on the front or side of the abdomen, according to the indications in the particular case; and after drawing off the fluid the cyst should be cut into, and the edges of the cyst stitched to the edges of the parietal wound. Under these circumstances the cyst will collapse, and either with or without suppurating, will probably close. If a fistula should remain and prove troublesome, the question of nephrectomy may be considered; but it must be borne in mind that the kidney structure in these cases is functionally useful, and therefore the organ ought not to be sacrificed without specially strong reasons.

Renal cysts of Congenital Origin.—Renal cysts, like hydronephrosis, are sometimes congenital, and lead to enormous abdominal distension of the fœtus in utero. Parturition is sometimes thus rendered difficult, or even impossible, and the child when born presents the appearance of one having an ovarian cystic tumor. Cystic degeneration, with abdominal distension, is a cause of death of the fœtus in utero, or during birth; and it is sometimes found associated with various malformations, such as talipes, cleft palate, and imperforate anus.¹

CYSTS OF THE SPLEEN.—Cysts, other than hydatid, are very rare indeed in the spleen. Large simple serous cysts of this organ have been occasionally met with. M. Péan successfully removed a hypertrophied spleen containing a large cyst. The *symptoms* would be those due to pressure, and would not differ from those caused by serous cysts of the kidney or other organs. In the early stage, their *diagnosis* would be attended with all the difficulties which attend that of renal cysts, and in their later stages there would be the same resemblance to ovarian cysts. The *treatment* should at first consist in aspirating the contents, and, if the cyst should refill, the same treatment

¹ See cases reported in the *Transactions of the London Obstetrical Society*; and a paper of mine in the *Proceedings of the Royal Medical and Chirurgical Society of London*, for 1876.

should be adopted as has been recommended for other abdominal cysts. Splenectomy, unless obstinate suppuration occur, or hypertrophy of the organ complicate the cyst, as in Péan's case, can seldom, if ever, be requisite or justifiable.

CYSTS OF THE PANCREAS.—Though the pancreas is, rarely, the seat of a hydatid cyst, the common cause of cysts in this organ are such as give rise to obstruction of the pancreatic duct. Calculous concretion in the duct, is by far the most frequent cause of cystic dilatation; but any other obstacle to the free escape of the pancreatic secretion will produce the same result. Thus cancer of the duodenum, a gall-stone impacted at the lower end of the common bile-duct and pressing upon the orifice of the pancreatic duct, marked induration of the pancreatic tissue, or peri-pancreatic adhesions, especially those which tend to displace the pancreas, are possible causes of cystic formations. Dilatation of the ducts of the pancreas, whether sufficient to constitute a large cyst or not, is a very frequent result of the impaction of pancreatic calculi. From the analogy of these distension-cysts with the cysts of the salivary glands, Virchow has given them the name of "*Ranula pancreatica*." Mr. Joshua Parsons made the same comparison in 1857, in his report of a case of pancreatic cyst which will be mentioned hereafter. As in the case of the ureter, the pancreatic duct, if the obstruction is complete and near its bowel-end, may become dilated throughout; and the accessory or branch ducts may present the appearance of diverticula opening into the duct of Wirsung. From local interstitial inflammation, or catarrh of the lining membrane, or from a plug of mucus, one of the smaller ducts alone may be affected, while the main duct remains pervious.

The cysts of the pancreas vary much in size and form. In some cases, the cyst-wall is thick, tough, fibrous, cartilaginous, or even osseous: the inner surface may be smooth, or may present fatty, chalky, or albuminous changes like those seen in diseased arteries. In very large or old cysts the walls sometimes suppurate. By the pressure exercised by the cyst, the gland-tissue atrophies, or undergoes adipose transformation; and the effects of pressure upon the surrounding structures are very various. "The portal vein, inferior cava, and splenic vein; the pylorus, duodenum, colon, gall-bladder, and biliary passages; the stomach, liver, spleen, and right kidney; and, lastly, the solar plexus of nerves may be structurally involved or locally displaced, rendering diagnosis most difficult, and post-mortem examination most unsatisfactory." So writes Dr. Johnston, in an admirable article on Calculous Affections of the Pancreatic Ducts.¹

The contents of the cysts may be either altered pancreatic secretion, or nearly pure mucus, or a serous fluid; cholesterine, broken-down cells, pus, blood, and crystals of hæmatine have been found in a large number of cases. In Bozeman's case, which will be again referred to, the fluid was of a light-brown color, specific gravity 1020, and of acid reaction, thus differing from the fluid of ordinary ovarian cysts, which is alkaline. Calculous concretions are sometimes formed in the cysts. Dr. Johnston has forcibly pointed out that not only do calculi, by occluding the pancreatic duct, cause the formation of retention-cysts, but that pancreatic cysts, however caused or formed, favor the occurrence of calculi. The capacity of the cysts varies from several drachms to ten or twenty ounces; in exceptional cases, very much more has been found. Bozeman speaks of two and a half gallons of fluid having been drawn off, in the case of his patient, and adds that the tumor, with the fluid, weighed twenty and a half pounds.

¹ Amer. Journal of the Medical Sciences, Oct. 1883, p. 418.

Any part of the pancreas may be the seat of the cyst; and thus the tumor may occupy either the right or the left hypochondrium, or the epigastrium, or may be below the right lobe of the liver, or between the stomach and spleen, or in front of the spine. The cysts which spring from the middle part of the pancreas are the most likely to be early detected as abdominal tumors, on account of their being pushed forward by the bodies of the vertebrae.

Terminations.—The cyst may rupture into the stomach, duodenum, or colon, into the peritoneum, or behind the peritoneum. Extravasation of blood into the cyst is very likely to happen, and its occurrence is evinced by the chocolate-brown color of the cyst-contents, or by the bright redness of the fluid, if the hemorrhage has been quite recent. Sudden death is sometimes caused by intra-cystic hemorrhage. Atrophy, fatty degeneration, or inflammatory disorganization of the whole of the pancreas is prone to follow the development and growth of these cysts.

Symptoms.—The symptoms of pancreatic cysts are very various. Abdominal pain, gastric disturbance, emaciation, and the presence of an abdominal tumor, over the surface of which the tympanites of stomach, duodenum, or colon can be detected, are to be expected. When the cyst is due to distension, there may be jaundice, and fatty stools, with an inordinate appetite, or craving for food. Symptoms such as those last mentioned are brought about by the pressure of an impacted calculus against the common bile-duct, and by the complete obstruction to the flow of pancreatic secretion into the intestine. When the bile-duct, as well as the pancreatic duct, is thus completely obstructed by a pancreatic calculus, the evil consequences of the non-digestion of fat are still more marked. The occurrence of jaundice and fatty stools from the lodgment of a calculus in the duodenal end of the duct of Wirsung, should be borne in mind in considering the causes of biliary obstruction. Diabetes mellitus should also be looked for, especially when the cyst springs from the centre of the pancreas, since it is believed that atrophy and destruction of the coeliac plexus may give rise to the presence of sugar in the urine. Such cases do not, in my opinion, lend any color to the theory that diabetes mellitus is in any essential manner the result of morbid changes in the pancreas, but simply show that diabetes may follow if disease in the pancreas leads to secondary changes in the sympathetic ganglia and plexus.

A case recorded by Mr. Parsons,¹ shows the difficulty in ascertaining the exact cause of every case of pancreatic cyst, and furnishes an interesting example of the mode in which some of them progress and terminate:—

A lady, aged sixty, the mother of ten children, had been for many years subject to occasional spasms of the stomach. At length she was seized by a very severe attack of spasm, followed by gastric inflammation, and ending in chronic gastritis. Four months after this acute attack, a tumor was discovered in the epigastrium, the size of a small orange, slightly movable, situated immediately in front of the spine, and behind the stomach. For a fortnight the tumor slowly increased, and then suddenly disappeared one night, with the passage of frequent stools of a glairy consistence, dirty-white color, and an odor like saliva. Temporary relief was followed by a return of the tumor, and by symptoms of renal irritation, with much pain and tenderness in the left lumbar and iliac regions; and after a few weeks a second tumor appeared immediately above the anterior superior spinous process of the ilium, and was plainly continuous with the former tumor—increased tension of the one being produced by pressure on the other.

For many weeks no notable change occurred, but the last formed tumor slowly enlarged, and there were great suffering and increasing emaciation and debility.

¹ Brit. Medical Journ., June 6, 1857, p. 475.

Nine months from the time of the acute illness with which the disease began, the diarrhœa returned, with subsidence of the swelling and relief of the pain. This lasted two days, and then the tumor filled somewhat suddenly again. In ten days, the diarrhœa returned with copious vomiting, much dark, grumous blood being ejected both from the stomach and bowels. The tumors became flaccid and non-fluctuating, though still perceptible. The patient became extremely emaciated, and within less than ten months from the original seizure, died quite suddenly, with all the symptoms of internal hemorrhage. At the post-mortem examination there was found to be no peritonitis. The smaller curvature of the stomach, and what remained of the pancreas, were bound down tightly by adhesions to the spine, and these firm adhesions extended by the spleen and left kidney to the left iliac fossa. By these adhesions, a canal was formed, in which was the diseased pancreas, consisting, apparently, of a long cystic tube, extending from the duodenum to the left hypochondrium, and fully six inches in length. Behind the descending colon it became a cavity, the size of the fist, containing throughout a dark grumous fluid, like decomposed blood. The walls of the cyst were of cartilaginous hardness. There was, also, recent blood extravasated within the cyst. The tumor was adherent to the colon, and this part of the gut was soft and disorganized, but not ulcerated. The left kidney was softened and disorganized, but contained no calculus. The spleen was small, soft, and black. The left pleura contained much serum; the left lung was collapsed. The other organs were healthy, but wasted.

Treatment.—In the earlier stages the diagnosis must be uncertain, and nothing except the relief of prominent and distressing symptoms will be possible. For the amelioration of gastric irritability, sickness, and pain, freshly made whey, holding small quantities of soda in solution, has been found useful in counteracting the acrid gastric secretions to which the patients seem liable. In certain cases when the tumor is evident, an exploratory incision should be made, and the cyst either emptied by an aspirating trocar and its walls stitched to the parietes, or the cyst itself extirpated bodily. Kulenkampff, of Bremen, has recently evacuated a litre of fluid from a pancreatic cyst, the walls of which he had previously united to the parietal peritoneum. A drain was kept in for a time, and a temporary fistulous opening resulted; but it ultimately closed within a few weeks. Thiersch has treated a cyst of spontaneous origin in the same way, letting out three litres of chocolate-colored fluid; but in his case a fistula remained.

Pancreatic cysts have within quite recent years been removed by operation. Rokitsansky, of Vienna, and Bozeman, of New York, have each performed the operation, but each under the impression that the tumor was ovarian. Rokitsansky was not able to complete the extirpation, in his case, on account of adhesions to the omentum, stomach, and transverse colon. The patient nearly died on the table, but rallied and lived until the tenth day. Bozeman's patient was forty-one years old, and the disease had been observed five years before the operation. The pedicle of the cyst was three-quarters of an inch long, and was attached to the tail of the pancreas; it was ligatured before the cyst was cut away. The patient completely recovered.¹ [Another successful case, with persisting fistula, however, is attributed to Gussenbauer,² and a fatal case, in which intestinal obstruction was caused by an abscess of the pancreas, to Rosenbach.³]

CYSTS OF THE MESENTERY, OMENTUM, AND PERITONEUM.—Simple cysts of the mesentery are occasionally met with, but they are rare. In their early stages they are difficult to diagnose, and in their later stages they are likely to be mistaken for ovarian cysts. This is the case with all or at least most intra-abdominal cysts of simple or serous character, as well as with others of

¹ Am. Journ. Med. Sciences, April, 1882, p. 572.

² Med. News, April 28, 1883.

³ Gaz. Méd. de Strasbourg; and Med. News, Sept. 30, 1882, and Feb. 3, 1883.

less simple nature. Rokitsansky says of the serous cysts of the peritoneum—regarding them as inflammatory products—“a pseudo-membrane includes, during its organization, a portion of the fluid exudation, and receives an internal serous investment. Such bladders are either connected with the peritoneum by means of a neck or stalk, or adhere to it by a broad base.”¹ Knowsley Thornton has removed a cysto-sarcoma weighing twenty-five pounds from the mesentery; and in another case a multilocular cystic tumor which was situated in the omentum. Thornton believes that these cysts originate in the sub-endothelial layer of the peritoneum, and he refers to a case in which “the whole cellular tissue of broad ligament, pelvis, peritoneum, etc., seemed to have undergone cystic degeneration, the cysts all containing solid papillomatous growths.”² Habershon describes a case of “fibrous cyst which could in great measure be separated from the peritoneum, and contained many pints of slightly milky serum;” it reached from the right iliac region as high as the liver, and closely resembled ovarian dropsy; it is described as a “spurious cyst in the peritoneum,” and was considered to have been of inflammatory origin—a view supported by the fact that another cyst was found between the colon and the stomach, and that the intestines were matted together.³

Dr. Buckner⁴ relates a case of simple cyst of the mesentery which he mistook for an ovarian tumor. He completely removed it from between the layers of the peritoneum forming the mesentery, and divided and ligatured the superior and middle mesenteric arteries in doing so. The patient recovered.

Mr. Lawson Tait⁵ met with a very similar cyst, which he mistook for a parovarian cyst and exposed by laparotomy. After tapping the cyst he stitched its edges to the edges of the external wound, and introduced a drainage tube. The patient recovered.

A case of cystic tumor of the mesentery, which caused death by intestinal obstruction and peritonitis, occurred at St. George's Hospital.⁶ The tumor was filled with a semi-solid, milky-white matter like putty, and a milky fluid; it hung down into the right side of the pelvis, and no less than four coils of intestine were found wound around it; the lower end of the small bowel was twisted cork-screw fashion around a stem formed by the mesentery. The pulsatous cyst-contents consisted of fat with much granular matter. The cyst itself was of a fibrous structure. The mesenteric glands—some of which were in contact with the cyst—were quite healthy. The ovaries were healthy. It occurred in a married woman aged twenty-three, who had been confined four months before, and who was suckling when attacked by the symptoms of peritonitis and obstructed bowel, which ended fatally in ten days.

Dr. Werth, of Kiel,⁷ has reported a successful extirpation of a cyst of the mesentery, which was supposed to have originated in the mesenteric lymphatic glands. The woman had noticed the tumor three months before she sought advice; it was discovered during a sharp attack of colic, from which she often suffered, especially at meal times and after unusual exertion. She was reduced in strength and emaciated. The tumor lay above the pelvic inlet and was very movable; it was unconnected with the uterus and ovaries. Soon after an examination under chloroform, severe pain came on about the umbilicus, and the tumor, which had before lain close to the abdominal wall, sank into the pelvis and was covered by intestine. A tense cord could be felt on the left, near the middle line, running from the umbilical region to the pelvic inlet. Laparotomy was undertaken on account of excessive vomiting and failing strength. The intestines being pushed aside, this cord was found to run from the root of the mesen-

¹ Manual of Path. Anatomy, Syd. Soc. Translation, vol. ii. p. 18.

² Trans. Path. Soc. Lond., vol. xxix. p. 150.

³ Pathological and Practical Observations on Diseases of the Abdomen, etc., p. 573.

⁴ Am. Journ. Med. Sciences, Oct. 1852.

⁵ Diseases of Ovaries, 4th ed., p. 223.

⁶ British Med. Journ., May 16, 1857, p. 405.

⁷ Archiv. für Gynäkologie; Med. Times and Gazette, July 8, 1882, p. 52.

tery to the tumor in the pelvic cavity. The tumor was within the mesentery, covered by a loop of intestine, and by a ring of mesentery like a ruff. Pappy fluid was exuded at two small round openings. The margins of the wound in the mesentery were brought together by catgut sutures. Some enlarged mesenteric glands, as well as the tumor, were enucleated. The patient recovered perfectly. The cyst-contents consisted of albuminous and fatty detritus without any formed elements; this Dr. Werth takes to have been inspissated chyle.

Rokitansky has described cysts of this kind. Probably Dr. Pitman's case, at St. George's Hospital, was one of chylous cyst. Klebs, Eppinger, Roth, and Péan, have recorded cases of cyst of the mesentery, but not of the same nature as Werth's and Pitman's.

CYSTS OF THE URACHUS.—Besides the permanently tubular condition of the vesical end of the urachus which has been many times observed, and to which attention has already been drawn under the name of urachal fistula, pouches or cyst-like dilatations of the urachus are sometimes found in the abdominal wall, or at the umbilicus. These cysts are results of the imperfection of the embryonic changes which should entirely obliterate the tube of the urachus. They are situated in the cellular tissue immediately outside the parietal peritoneum, and though often small, they may attain such a size as to simulate ovarian cystic disease. Their contents are serous, their growth is slow and painless, and they may be multiple; one instance at least has been reported in which there were three immense cystic dilatations. When situated at the umbilicus they may be mistaken for umbilical hernia; but the soft, elastic, and perhaps fluctuating feel—possibly the translucency—and certainly the history and irreducibility of the swelling, will assist to a right diagnosis.

Small cysts of the urachus are occasionally met with when dividing the abdominal wall; and Mr. Lawson Tait has related two cases of large extra-peritoneal cysts which he believes to have been urachal, and which in some respects closely resembled in their clinical characters ovarian or parovarian tumors.

In each of these cases a large cyst was situated between the transversalis fascia and the thickened peritoneum; in each case a large quantity of thick, brown, purulent fluid, mixed with large masses of fibrinous deposit, was contained within the cyst. In one case the cyst had been tapped, and ten pints of this fluid had been drawn off; subsequently thirty pints were withdrawn from it, and the cyst was removed in its entirety; the intestines and pelvic organs were non-adherent, and apparently healthy, and could be felt through the exposed but unopened peritoneal membrane. The inner surface of the cyst was composed of broken-down mucoid epithelium, infiltrated everywhere with pus, and lying upon a basement-membrane of muscular fibre. The tumor, though entirely extra-peritoneal, dipped into the pelvis on the right of the median line. In the second case the cyst was gangrenous. Both patients succumbed to the operation.

It is a remarkable thing, if the theory of the urachal origin of these cysts is correct, that the cysts remained so many years in abeyance, and then suddenly developed to such an enormous size.¹ The fatal results in these cases point out the risk there is in removing large extra-peritoneal tumors from the abdominal parietes. The vitality of the exposed and disturbed peritoneum is likely to be destroyed, and therefore incision and drainage would

¹ As bearing upon cases such as these, the reader is referred to a paper by Mr. Knowsley Thornton, in the twenty-ninth volume of the Pathological Society's Transactions (p. 145), on a case of "Peritoneal cysts, with blood-cyst of left ovary." Mr. Thornton believes the cysts in his case to have arisen in the sub-endothelial cellular tissue, and to have pushed the peritoneum and its contents aside. The cysts were removed, but the general peritoneal cavity was never opened at all—the ovary having been reached through two adherent layers of peritoneum.

seem the better practice. Mr. Tait is of opinion that it would be best to remove a large portion of the denuded peritoneum, "and trust to a careful arrangement by sutures of the portions left."¹

DISTENSION OF THE GALL-BLADDER.

The gall-bladder may be distended by bile, thin mucoid fluid secreted by its own lining membrane, pus, gall-stones, or cancer, and several instances have been recorded in which, after death, the viscus has been found distended with air.

DISTENSION OF THE GALL-BLADDER WITH BILE is a common consequence of obstruction of the common bile-duct, but it occurs also independently of such obstruction. An old man, aged 87, died from concussion of the brain, cystitis, and pyelitis, eleven days after an injury to his head. The gall-bladder was completely stuffed with a mass of dry, mortary, inspissated gall, which was adherent to the thickened walls of the gall-bladder; there was no obstruction in the ducts. The commonest cause of obstruction is a biliary calculus; other occasional causes are a growth in some part of the duct, pressure upon the duct by a tumor in some neighboring organ, and obliteration of the duct at its intestinal extremity by an ulcer or cancer of the duodenum. Murchison² relates a case of enlargement of the gall-bladder with atrophy of the liver, caused by obstruction from a cicatrix after a duodenal ulcer. Dr. Vanderbyl³ records one in which obstruction was due to cancer of the pancreas. Dr. Martin Oxley⁴ has recently put on record a case of abdominal tumor, the size of a cocoanut, situated below the free margin of the liver, and caused by congenital atresia of the duodenal end of the common bile-duct. The child was five weeks old, much jaundiced and emaciated, and thirty-six ounces of bile flowed out on puncturing the tumor. A few days subsequently, this was tapped again, and sixteen ounces of bile were drawn off with Southey's tube and trocar. Four days after the second tapping the child died, and it was found that the tumor (which had existed from birth) was due to dilatation of the gall-duct, the gall-bladder being of normal size and empty; there was no opening from the common duct into the intestine.

The *symptoms* of distension of the gall-bladder from such causes as the above, are jaundice, absence of bile in the feces, presence of bile in the urine, and general fulness and tenderness of the liver. The tumor is pyriform in shape, and elastic, if not fluctuating, and it projects downwards from beneath the edge of the liver, in the normal situation of the gall-bladder. Its dimensions vary; the accumulation has been known to amount to twelve pounds⁵ and upwards, the size of the sac being proportionally increased, so as to occupy a very considerable portion of the abdominal cavity. Dr. Bright⁶ has recorded a case in which the gall-bladder, distended with bile, formed an oval tumor descending nearly to the crest of the ilium. M. Petit⁷ mentions two cases of puncture of the distended gall-bladder which proved fatal; in one case two [French] pints of very green and viscid bile were discharged, and in the other about a chopine⁸ of green bile. In Cline's case 20 ounces of bilious fluid were drawn off with a canula, and after death on the seventh day, the gall-bladder was found to extend down to the pelvis, and to contain

¹ Diseases of the Ovaries, 4th edition. 1883.

³ Trans. Path. Soc. Lond., vol. ix. p. 228.

⁵ Dr. William Thomson, op. cit., p. 73.

⁷ Mém. de l'Acad. Roy. de Chir., tome i. p. 256.

⁸ [Half a French pint, a little over 16 fluidounces.]

² Diseases of the Liver, Case LXI., p. 365.

⁴ Lancet, December 8, 1883, p. 988.

⁶ Op. cit., p. 271.

two quarts of bile; the biliary ducts were also greatly distended, except where the common duct entered the duodenum, and here was a contraction through which bile could only be squeezed with difficulty. Mr. Todd, of Dublin,¹ opened an enlarged biliary duct in a girl aged 14, supposing it to be an hepatic abscess, and two quarts of viscid, green bile were evacuated through a canula.

Some variety will also be found in the other symptoms; thus, if the dilatation be due to obstruction of long standing, the liver may at length contract to less than its natural size, in place of being full and enlarged. If the accumulation have arisen from impaction of gall-stones at the neck of the gall-bladder, or in the cystic duct, and these act like a valve, so as to allow the ingress of bile but not the egress, there may be no jaundice, no clay-colored motions, and no bile-pigmented urine. Such cases are, however, rare. The tumor may suddenly subside, owing to the dislodgment of the obstruction, in which event bile will be discharged freely with the feces, and the jaundice will soon disappear. If the subsidence of the tumor is the effect of rupture of the thinned or degenerated coats of the gall-bladder, fatal peritonitis will set in. In some cases the bile is gradually absorbed, though the obstruction remains, and then shrinking of the gall-bladder takes the place of distension. If, as sometimes happens, distension arises without any obstruction of the ducts, the gall-bladder may be emptied by pressure upon the tumor. In a case related by M. Petit, in which he was about to open a tumor in the hepatic region under the impression that it was an abscess, he had scarcely cut the skin when the tumor sensibly collapsed, and the patient shortly afterwards discharged a quantity of green bile. In another case of Petit's, the gall-bladder could be sometimes diminished by pressure, and sometimes underwent spontaneous evacuation. In a case in which I was asked to aspirate or otherwise open an abdominal tumor which was supposed to be, probably, hydatid, I declined to interfere, as I believed from the slightly icteric hue of the skin, the pale feces, and the high-colored urine, that the enlargement was more probably due to distension of the gall-bladder from a temporary cause. My colleague, at this suggestion, at once acquiesced in delaying puncture, and the diagnosis was confirmed in a very short time by the spontaneous disappearance of the tumor, the return of the stools and urine to their natural character, and the rapid general improvement in health. It is unwise to make any forcible attempt to reduce such a swelling by manipulation or pressure, for, as Bright pointed out, after long distension the walls of the gall-bladder become so thin that they may give way under ordinary handling. He refers to a case in which this actually occurred during post-mortem examination.

DISTENSION OF THE GALL-BLADDER WITH FLUID SECRETED BY THE MUCOUS GLANDS AND EPITHELIUM OF THE SAC.—This is what is known as "dropsy of the gall-bladder" (*Hydrops cystidis felleæ*), and as *Cholecystonchus*. The longer the obstruction has existed, the freer the fluid from admixture with bile; and if the distension is very extreme, its coats may be so thin that the gall-bladder, as Walther has remarked, is as pellucid as the bladder of fishes. The characters of the fluid vary, and it appears that the mucous secretion of the gall-bladder often deviates from the normal standard. It may be a thin and flaky, or a thick and starchy fluid, coagulable into a firm mass by heat, acids or alcohol, and, except that the coagulum seems denser, it very accurately resembles serum.² It is a sero-mucous fluid, either transparent or colorless, and is derived from a membrane in a state of chronic inflammation.

¹ Dub. Hosp. Rep., vol. i. page 325.

² W. Thomson, op. cit.

The tumor caused by the accumulation of this fluid is generally painless, but not always so; and it is sometimes tender to the touch. Though the patient suffers headache, sickness, and constipation, and grows thin, the tumor is unattended by febrile disturbance, and is thus distinguishable from an abscess. Its formation is commonly preceded by biliary colic, and this symptom, with the situation of the tumor, distinguishes it from the kind of enlargement for which it is most likely to be mistaken—namely, a hydatid cyst. When examined with the patient under chloroform, the gall-bladder, whether distended by bile or by this dropsical fluid, is often freely movable in a lateral direction, and, though its base is fixed, the fundus and apex can be sometimes pushed across to the left of the middle line. On percussion, a tympanitic note is elicited on the sides of and below the tumor. If the distension be caused by obstruction at the neck of the gall-bladder, or in the cystic duct, jaundice will not be present.

DISTENSION OF THE GALL-BLADDER WITH PUS.—This subject having been entered into when considering Biliary Abscess, need not be further discussed here.

DISTENSION OF THE GALL-BLADDER WITH CALCULI.—The mode of formation of gall-stones is an unsettled question, but it is probable that they result from precipitation from the bile, either as the effect of a diminished amount of cholate of sodium in the bile, or as a concretion around any foreign body, such as inspissated mucus or blood-clot, in the same way that urinary calculi are formed.

Gall-stones are composed of cholesterine, bile pigment, and earthy matter. Some are formed of pure cholesterine, and are then translucent, crystalline bodies; but most gall-stones, especially if of any size, are composed of all three substances, and are of a yellowish, brownish, or black color. Often the centre of a gall-stone is black, as if of pure pigment, and from it lighter lines radiate; sometimes layers of crystalline cholesterine and pigment regularly alternate. When the gall-bladder is distended with or contains several stones, they are polygonal, with smooth facets from the attrition or pressure of one against another.

The tumor formed by an aggregation of gall-stones, is hard and nodulated, and resisting. On palpation it gives a peculiar, crackling sensation, and a sound which has been compared to that caused by rolling small pebbles about in the mouth. The tumor does not vary in size from time to time, except that it increases, which it does very slowly. It is usually movable, and, though not always, is sometimes the seat of much pain; but whether actually painful or not, uneasy sensations are generally experienced over the hepatic or renal region from time to time. Jaundice is a common symptom, and a history of biliary colic is generally given. In some instances attacks of colic attended with agonizing pain occur at regular intervals throughout the course of the case.¹ In some there is a sensation of a heavy weight rolling from side to side in the situation of the gall-bladder, on turning in bed.² Vomiting is often excited, and the tumor has been known to cause all the symptoms of stricture of the pylorus. Mental depression, hypochondriasis, and symptoms suggestive of disease even in distant organs and parts of the body, may be caused in nervous persons by accumulated gall-stones. If ulceration is set up by the calculi, local peritonitis with acute pain must be looked for. In other cases the inflammation leads to very great hypertrophy of the coats of the gall-bladder, which have been found to be even half an inch thick.

¹ Daly's case, *Trans. Clin. Soc.*, vol. x. p. 11.

² Murchison, *op. cit.*, p. 500.

ENLARGEMENT OF THE GALL-BLADDER FROM CANCEROUS DEPOSIT IN ITS COATS.—Cancer attacks the gall-bladder primarily, and spreads from it to the liver and peritoneum; or it invades the gall-bladder secondarily to the liver, pancreas, or pylorus, or it may even be some other and more distant organ. In most cases in which the gall-bladder is affected with cancer, it will be found to contain calculi.

The *symptoms* are severe shooting pains, with great tenderness on manipulation of a hard, and probably nodulated, tumor in the region of the gall-bladder. The tumor is usually fixed, and its growth rapid; it is sometimes soft in the centre, or at some other part of its surface, and then an external fistulous opening may be expected. In other cases the fistulous communication is with the colon, duodenum, or stomach, and then blood, and perhaps a biliary concretion, may be ejected through the mouth or voided by the rectum. The general impairment of health, and the emaciation and prostration, are more marked and rapid than in any other form of enlargement of the gall-bladder. Soft cancer of the liver is very likely to be mistaken for distended gall-bladder.

As a result of any form of mechanical obstruction to the flow of bile into the bowel, the biliary tubuli, as well as the bile-ducts, may be dilated; this is more especially likely to occur when the obstacle is in the hepatic duct, and when the gall-bladder is, therefore, not a vent-space for the impacted fluid. The distension of the tubuli may be so extreme that a sensation of fluctuation is communicated to the fingers applied over the surface of the liver.¹

Treatment of Distension of the Gall-bladder.—The diagnosis of the cause of the enlargement must be made, and the treatment directed accordingly. In cases of over-distension from bile, the medicinal and dietetic remedies in common use for temporary obstruction must be employed, and will generally be followed by relief. In cancer, secondary to cancer of some other organ, the relief of symptoms as they arise is all that can be hoped for; but if the disease is primarily of the gall-bladder, the extirpation of the sac by abdominal section should be attempted. In cases of distension with pus and calculi, and in those instances of accumulation of bile or mucus in which other remedies have failed, operative measures will be required.

Whilst it must be borne in mind, on the one hand, that in distension without obstruction, the tumor may, at any moment, spontaneously subside; and that where permanent obstruction does exist, the bile or mucus may become absorbed, and the liver more or less destroyed or atrophied—in which case, either no necessity would exist for, or no permanent good would result from, the evacuation by puncture or incision—still, on the other hand, there is danger in all cases in which the tumor is rapidly increasing, that its thin walls may give way towards the peritoneum; or in cases of suppuration that the constitution may be worn out by hectic; or in cases of distension by biliary concretions, that death may be caused by the irritation, gastric disturbance, and emaciation, to which they give rise. M. Petit considered, as have many others, that there ought to be adhesions between the sac and the parietal peritoneum before the gall-bladder could be successfully punctured, and suggested the following as indications of such adhesions having been formed: (1) The impossibility of making the tumor change its position; (2) Edema and redness of the integuments over the tumor; (3) Frequent recurrence of local inflammation. It is, however, very difficult to be quite sure of these adhe-

¹ Dr. Wm. Thomson, op. cit., p. 73.

sions; and, fortunately, it is unnecessary to be so for the safe performance of either aspiratory puncture or cholecystotomy.

Dr. E. L. Dixon¹ relates a case in which the gall-bladder was tapped five times with great relief, and a total of eighty-seven and a half ounces of liquid were withdrawn by the aspirator. The patient was jaundiced, and the common bile-duct was obstructed with cancer; so that though life was prolonged and eased, it was not saved by the operation.

CHOLECYSTOTOMY.

Under this term it is not intended to include those procedures, of which several are on record, for dilating fistulous openings for the removal of biliary calculi which have been detected by a probe, or finger, passed along a fistulous track. As in similar cases of stone in the kidney, such measures differ entirely in their conditions from a planned operation where no fistula exists. Cholecystotomy, like some other abdominal operations, has been long thought of, rarely performed, and strongly condemned, but now at last seems likely to find a recognized place in abdominal surgery. [It was clearly described, and distinctly advised in suitable cases, by Sharp,² of Guy's Hospital, in the middle of the last century.] In Good's Study of Medicine,³ we find it stated that "Formerly, when the gall-bladder was suspected to be completely gorged, its walls thickened from long-continued irritation, the concretions too large to be forced forward, and the pain permanent and severe, attempts were made to remove them by a section into the cyst. Bloch gives a singular case of this kind, in which not fewer than sixty-two distinct calculi were taken away with success. But, in general, the operation has not answered, or has been followed by a formation of other crops of concretions; so that Morgagni, and many later writers of eminence, have strongly reprobated the use of the knife, and it is rarely or never had recourse to in our own day." Again, Dr. Andree⁴ had long before written, "Lithotomy has been advised for the removal of biliary calculi. This, however, has arisen from the uncandid representation of a very uncommon case, but one which has, I know, occurred, to wit, of an abscess forming between the calculus and the integuments of the abdomen;" and he continues, describing a case of fistulous track leading to a calculus which was thus removed. In a case of Petit's, in which the tumor was opened contrary to his advice, on the supposition that it was an hepatic abscess, a fistula formed, and a calculus was extracted. In October, 1859, Dr. Thudichum urged the advisability of removing gall-stones by incision. In October, 1875, Dr. Daly and Mr. Maunder⁵ discussed the operation of cholecystotomy in reference to a case of gall-stone impacted in the gall-bladder, and had Maunder been able to feel the gall-bladder or the stone, he was prepared "after the manner of gastro-enterotomy to cut down on the gall-bladder and secure it to the side; then, after adhesion had taken place, open the bladder and remove the gall-stone." The operation, however, was not done; the patient died; and it was found that, besides the stone in the gall-bladder, a still larger one was impacted in the common bile-duct, that all the biliary tubes, both within and without the liver (except the cystic duct) were dilated, and that there were numerous small abscesses in the liver substance.

¹ Practitioner, April, 1876.

² Critical Enquiry into the present state of Surgery, 2d edit., p. 223. London, 1750.

³ Op. cit., edit. 1825, vol. i. p. 420; *ibid.*, edit. 1840, vol. i. p. 349.

⁴ Considerations on Bilious Diseases, etc., pp. 45 and 64. 1790.

⁵ Trans. Clin. Soc., vol. x. p. 14.

In April, 1878, Dr. Marion Sims¹ deliberately planned and performed the operation in a case of dropsy of the gall-bladder, and removed about sixty stones as well as the fluid contents; the patient died eight days after the operation, and at the post-mortem examination there were found other sixteen stones in the gall-bladder; all the biliary ducts were sacculated, and the small biliary tubes within the liver were much enlarged. Since then the operation has been performed by Mr. Lawson Tait,² Mr. Meredith, of the Samaritan Hospital for Women, London, and other surgeons [including Kocher, Rosenbach (two cases), Savage, Bobbs, Ransohoff, Winiwater, Gardner, Eddowes, and Keen, who has operated twice, and, in conjunction with Dr. J. H. Musser, has published an interesting article on the subject].³

Mr. Tait informs me that he has now operated on ten⁴ occasions; that all the patients have recovered, and that in every case, save one, the operation has been successful in its results. In these nine cases the cause of the distension was calculus, and the contents of the gall-bladder mucus, though in three cases suppuration was beginning. Mr. Meredith's case has not yet been published, but he has furnished me, very kindly, with the full notes of it. Three stones, weighing collectively 1 ounce 26 grains avoirdupois, were extracted. The patient died forty-eight hours after the operation, but Mr. Meredith believes that the result would have been very different had the patient not had unsound kidneys, with almost complete suppression of urine some hours after the operation. At the post-mortem examination the gall-bladder (which had been stitched up and returned into the abdomen at the time of the operation) contained nearly a half pint of thick bile, the cystic and common duct were quite unobstructed, and the duodenum contained a considerable quantity of bile. There was no trace of peritonitis, although several ounces of dark bile were found free amongst the coils of small intestine; the bile, Mr. Meredith believes, escaped during the operation from the sponges introduced around the exposed gall-bladder, owing to the violent retching efforts of the patient whilst under the anæsthetic. The condition of the sutured wound in the gall-bladder, he adds, negatives the idea of the bile having escaped therefrom after the operation.

There are two methods of performing cholecystotomy, namely: (1) by the plan suggested by Maunder, in which the steps of the operation are divided by an interval of time into two stages—stitching the gall-bladder to the parietes, and waiting until after adhesions have formed before opening the viscus. Maunder adopted this practice in enterotomy, and it is now pretty commonly followed in gastrotomy. (2) The other plan is that carried out by Marion Sims, and followed by Lawson Tait. It consists in opening the gall-bladder and stitching it to the parietes at one operation. An incision from three to four inches long is made either in the linea alba (Tait), or over the outer border of the right rectus muscle (Meredith), or over the prominence of the tumor parallel to the linea alba (Sims). All bleeding should be stopped before opening the peritoneum. When the gall-bladder is exposed, it should be emptied of its fluid contents by the aspirator, and afterwards incised at the point of puncture, so as to admit the finger freely into its interior. Great care must be taken to hold the cut edges of the gall-bladder well up into the external wound, so that nothing shall escape into the peritoneal cavity. With minute pieces of sponge, in holders, the interior of the gall-bladder should be well cleansed, and any movable or loose calculi should be removed with ring forceps, or other suitable instrument. The edges of the wound in the gall-bladder should then be stitched with the continuous suture (Tait), or with

¹ Brit. Med. Journal, June 8, 1878.

³ Am. Journ. Med. Sciences, Oct. 1884.

² Med.-Chir. Trans., vol. lxi.ii.
[Since increased to thirty.]

several interrupted sutures (Sims used eight catgut stitches), to the upper end of the wound in the abdominal walls, leaving the opening into the gall-bladder quite free. Finally, the rest of the abdominal wound should be closed in the usual way. Great care should be taken to pass the sutures through the whole thickness of the parietes, including the peritoneum. Some light dressing, such as absorbent cotton-wool, boracic charpie, or lint soaked in carbolic oil, should be applied over the wound, and the abdomen lightly bandaged.

There are one or two other points requiring caution in the performance of this operation: (1) No part of the wall of the gall-bladder should be cut away. These walls are sometimes thick and vascular, and not attenuated, and Marion Sims found much delay and inconvenience from the hemorrhage which followed the removal of part of the organ. (2) If stones are impacted in the neck of the gall-bladder, or in its duct, or are encysted in the walls of the gall-bladder, much care must be exercised in any attempt to remove them, or the walls may be perforated, allowing bile to escape into the peritoneum. (3) If the calculus is adherent to the mucous membrane of the gall-bladder, the walls may easily be torn, unless extreme care and gentleness are exercised. It would be better to leave the calculi behind than to run the risk of killing the patient by lacerating the parietes of the gall-bladder. (4) In spite of the satisfactory condition of the wound of the gall-bladder, and the patency of the ducts, found on post-mortem examination in Mr. Meredith's case, I am inclined to the opinion that no attempt should ever be made to close up the incision in the gall-bladder so as to return the viscus to the abdomen. There is a possibility that bile may escape between the stitches into the peritoneal cavity; but granting that this risk is very remote, when due care is employed in adjusting the sutures, there is still another and more forcible objection. It is that the surgeon cannot be sure that a calculus is not impacted in some part of the common or cystic duct, beyond reach of his finger or forceps. It is well, therefore, to provide a fistulous opening through which accumulating bile, or calculi which are not detected or which cannot be removed at the time of the operation, may subsequently come away. (5) The operation ought not to be too long delayed. As in other cases in which the surgeon's aid is sought for, but which do not in the first instance come under his charge—such as intestinal obstruction, renal calculus, hydatid tumor, hæmaturia from vesical tumors, and the like—so in impacted gall-stones and distended gall-bladder, physicians would do well to advise an operation, even if sometimes it should have to be commenced in the way of an exploratory proceeding, before general dilatation of the biliary ducts within the liver has occurred, and before hepatic abscesses are likely to arise. It is no objection to cholecystotomy that it must sometimes fail to save life, even though performed successfully and recovered from readily. A gall-stone impacted in the hepatic duct, or in the common duct, may still keep up symptoms of jaundice and colic, and eventuate in death by ulceration or marasmus; but even in these cases there will be relief from the pain of distension.

The operation may be performed either with or without Listerian details; there is ample proof in Tait's results that they are not in the least necessary, though in the minds of many surgeons they will be regarded as affording increased security. Thus, Marion Sims concluded his remarks on his own case by saying:—

The great lesson this case teaches is this: In dropsy of the gall-bladder, in hydatid tumors of the liver, in suspected abscess of the liver, and in gall-stones, we should not wait till the patient's strength is exhausted, or till the blood becomes bile-poisoned, producing hemorrhages, but we should make an early exploratory incision, ascertain the true nature of the disease, and then carry out the surgical treatment that the neces-

sities of the case may demand. If this should be done under antiseptic precautions, I am sure that much suffering will be relieved, and many valuable lives saved that would otherwise be lost.

By all means let antiseptics be used with all the Listerian precautions, if by so doing surgeons may be able more readily to induce the physicians to follow Sims's teaching.

CHOLECYSTECTOMY.

In rare cases in which the condition of the coats of the gall-bladder makes it unsafe to leave the organ in the body, its removal should be undertaken. Langenbuch, of Berlin, on opening the abdomen found the gall-bladder hypertrophied and adherent to the neighboring tissues, and containing a large number of stones, some of them adherent to the walls and threatening perforation. The viscus was emptied by a Pravaz's syringe, the liver was raised, and the colon and small intestines were pushed down by a sponge, and then the gall-bladder was separated from the liver by a few touches of the knife. The cystic duct was thus laid free and was ligatured in two places with silk thread, and divided between the ligatures. Great care should be taken not to wound the liver in detaching the gall-bladder, and catgut ligatures should not be used for the cystic duct. Langenbuch's patient made a good recovery, though she had previously undergone nephrectomy for floating kidney. [Eighteen operations by Langenbuch, Krönlein, Courvoisier, and Thiriar gave sixteen recoveries.] S. W. Gross has removed the gall-bladder for calculi, and on the same patient he performed nephrectomy for cancer. It is not wonderful that the patient died on the second day of peritonitis: with a malignant disease and the shock of a nephrectomy simultaneously performed, the cholecystectomy had hardly a fair chance.

SURGICAL DISEASES OF THE KIDNEYS.

RENAL CALCULUS.—There is but a step between the formation of gravel and of stone in the kidney. If the solid substances which are usually in a state of solution in the urine become excessive, so as to be deposited as crystals, and if these crystals are carried out of the system with the urine, we have the condition of gravel. If these crystalline forms are cemented together by a little mucus or blood-clot, and are afterwards added to by fresh depositions from the urine, we have a small calculus, which may either be passed off with the urine, causing more or less renal colic in its transit along the ureter, or may remain behind in one of the calyces, or in the pelvis of the kidney, there to grow by fresh accretion until it attains a size altogether in excess of anything which can pass along the ureter.

Calculi may originate in the uriniferous tubes, or in one of the calyces of the kidney; but when started into being in the tubes, the calculus grows into importance in a calyx, or in the pelvis of the kidney.

The most common form of renal calculus is the uric-acid, the next most common is the oxalate-of-lime. These substances, being but very sparingly soluble, are the most likely to be precipitated from the urine; but carbonate of lime, phosphate of lime, a mixture of phosphate of lime and the ammonio-magnesian phosphate—that is, the fusible calculus—cystine, xanthine, and finally urate of ammonium or the mixed urates, are found occasionally, though rarely, either as the nucleus or chief constituent of renal stones. Alter-

nating calculi, of uric acid, oxalate of lime, and phosphates, in distinct layers, are not uncommon. It is said that in Egypt the eggs of the *Distoma hæmatobium* afford a nucleus for the formation of renal stones. Blood-calculi have been described, and a drop of dried blood is occasionally found as the nucleus of a mixed calculus. Dr. Scott Allison recorded a case of phthisis in which, after death, several black concretions varying in size from a coriander-seed to a horse-bean, and composed of blood of firm consistence, were found in the kidney. I have seen such concretions in the pelvis of a kidney in which a uric-acid and phosphatic calculus also existed.

Renal calculi are formed at all periods of life, from the latter weeks of intra-uterine existence up to quite old age. One or both kidneys may be affected at the same time, or one may become so subsequently to the other. One or many calculi may be formed in the same kidney, so that even scores have been found scattered through the organ. When the calculus is composed of oxalate of lime, it is generally single; when of uric acid it is often single, but it is far less likely to be so than when of oxalate of lime. In size and shape there is the greatest possible variety, from a small, round, smooth body, to a large, rough, and branched mass filling all the pelvis and calyces. Much depends upon the size of the stone, and also on its position in the kidney, as to the amount of damage wrought by its presence upon the renal structure. A stone as large as a marble, rough and sharply mammillated upon its surface, may remain confined to one of the calyces for years without giving rise to more change than induration of the whole organ, due to slight chronic interstitial inflammation. On the other hand, quite a minute stone, not much if any larger than a mustard-seed or grape-seed, whilst in the tubular structure of the kidney will excite congestion, and even acute inflammation and abscess. When a stone is of such large size that it fills the renal pelvis, or when, being much smaller, it falls like a ball-valve into the upper end of the ureter, it leads to chronic inflammation, to dilatation, and to those atrophic changes which accompany hydronephrosis and pyonephrosis; or nephritis, pyelo-nephritis, abscess in the perinephric tissues, or profuse suppuration within the kidney, may be the result.

Symptoms.—A small stone may develop, travel, and escape, without giving rise to any symptom. A stone of moderate or even of large size may exist for years without causing any noticeable symptoms; and, having been uncomplained of during life, may be met with as a surprise when the body is examined after death. As a rule, no doubt there is, at some time, blood or albumen mixed with the urine; some lumbar pain or aching, aggravated by exercise or by any jarring or jolting movement; some vesical irritability; perhaps some pain in the testicle of the same side. If the stone has existed a long while, pus, mucus, or albumen will be found daily in a minute, or moderate, or marked quantity in the urine; and if blood is not invariably present (and in many cases it is not), it sometimes occurs in large amount, making the water bright red, or porter-like in color, for several days together. If with these symptoms the patient from time to time passes gravel, or minute calculi, or fragments of calculous matter, the diagnosis becomes conclusive. Movements, such as those caused by carriage-exercise, running, or walking, are not in all cases needed to cause exacerbation of the lumbar pain: on merely turning in bed, or even when lying asleep, the patient may be aroused by a sudden agonizing seizure. It would thus seem that the varying pressure of the abdominal viscera, the passage of feces along the colon, the variations in the degree of intra-renal blood pressure, are all capable of exciting pain by making the, often, acicular surface of the calculus press against the renal tissue.

As soon as a stone enters the ureter, or is being propelled along it, stretching it as it goes—partly by the weight of the accumulating urine behind, partly

by the vermicular contraction of the muscular coat of the ureter, aided too, perhaps, by the retching and vomiting which its transit excites—renal colic sets in. The attacks of renal colic come on suddenly, last for hours or days, and almost as suddenly subside; to recur at some future period if the stone, instead of escaping at the lower end of the ureter, is simply displaced from the upper orifice into some less important point in the renal pelvis. Recurring attacks of colic arise also from fresh formations of renal calculus. I had a gentleman under observation, some time ago, who had had three distinct and severe attacks of colic; each lasted about three days, and they came on at almost time-regulated intervals of six months. From thirty-six to forty-eight hours after each attack, a small, irregularly rounded, smooth-surfaced calculus was voided with the urine. He was placed upon a regulated diet, and ordered soda water, with bicarbonate of sodium added to it, as a daily drink; and he has had no attack since—now nearly two years. During these attacks the pain shoots down the course of the branches of the lumbar plexus, and is felt in the bladder, in the groin, along the thigh, or in the testicle. The testicle may be retracted at the time, and afterwards become enlarged, and may remain for a long while tender if not painful. Women have occasionally aborted, men have committed suicide, and both men and women have been thrown into convulsions during the fearful agony of renal colic. The attack is often ushered in with a rigor, and is generally accompanied by vomiting, retching, and profuse perspiration. Faintness and collapse are by no means rare. The bladder is irritable; and the urine, which is diminished in quantity during an attack, is blood-stained and loaded with urates, and is sometimes passed with a good deal of scalding in the urethra. It sometimes happens that the other kidney becomes excited to increased secretion during the attack, and then the urine will not be diminished in quantity, and will not be thick. When the patient is very thin and the stone large, it can sometimes be detected on palpation of the loin.

It is important to know, with a view to surgical treatment, whether one or both kidneys are the seat of stone. There is usually not much difficulty in this, unless of course a stone is lying dormant in one kidney whilst symptoms are excited by the stone in the other; but it is necessary to bear in mind that a stone in one kidney will sometimes excite sympathetic pain and irritation in the other. This transferred or sympathetic pain is of an aching character, and not of a spasmodic or colicky description, as far as I have seen.

Treatment.—The treatment of renal calculus may be considered under three heads: (1) Prophylactic; (2) Palliative; and (3) Surgical or curative.

(1) *Prophylaxis* consists in employing a moderate amount of well-selected food, so as to preserve the digestive and assimilative functions in good order. Animal diet is not harmful if taken in moderation; nor is abstinence from an animal diet any security against calculus, as is proved by the prevalence of this disorder amongst the very poor, who scarcely taste meat. Immoderate eating, and an excess of animal or nitrogenized food, unquestionably conduce to the formation of renal calculus, and each individual ought to ascertain for himself what is moderation in his particular case, according to his mode of living, amount of exercise, and peculiarities of system.

(2) If a tendency to gravel or calculus is evinced, the free use of alkaline drinks is recommended as a *palliative* measure; so also is the employment of saline aperients, such as sulphate of sodium and magnesium, acetate of potassium, citrate of potassium, carbonate of lithium, or carbonate of lime; and the tartrates of potassium and sodium are also recommended. These remedies have, however, only a temporary effect; and for the most part the symptoms and the formation of calculous matter return soon after the discontinuance of the

remedies. The waters of Vichy and Ems are prescribed by those who prefer the alkaline diluents; of Carlsbad, Pullna, and Friederichshall, by those who advise the saline aperients. In either case, these waters are most advantageous when taken at their natural springs; the change of air, of mode of living, and of scene, all doubtless contribute to the improvement experienced. The solvent and preventive treatment of renal calculi will be more fully considered in the article on urinary calculus. During an attack of renal colic the treatment consists in the use of anodynes in large and repeated doses—sufficient to keep the pain in check. By allaying spasm they also facilitate the escape of the stone; and for the same purpose the hot bath, hot opium or belladonna fomentations to the loin and abdomen, and chloroform and ether inhalations, are useful. Anodynes may be given as morphia injections, subcutaneously; or in the form of morphia, opium, or belladonna suppositories. Warm diluents and diuretic drinks are sometimes recommended with a view of urging or pressing on the calculus by the corresponding increased secretion of urine, and its accumulating weight behind the stone. The patient should be kept in a relaxed posture, with the shoulders and thighs raised, thereby to diminish as much as possible the pressure of the abdominal parietes and contents upon the kidney.

(3) The *surgical treatment* of renal calculus will be hereafter considered under the heads of Nephrotomy, Nephrolithotomy, and Nephrectomy.

Nephrotomy, for a renal calculus which has given rise to abscess or fistula in the loin, or to a swelling which can be clearly detected through the parietes, is as old as the teaching of Hippocrates; but nephrolithotomy, for cases in which the symptoms of stone are subjective, and evinced only by pain, renal colic, and changes in the urine, is quite a modern procedure; and though now proved to be successful, was, till 1880, all but universally condemned. Nephrectomy, though of some years older date than nephrolithotomy, is also quite a recent innovation in surgical practice.

TUBERCULOUS AND SCROFULOUS KIDNEY.—Two forms of tubercle (so called) of the kidney are met with, (1) disseminated tuberculosis, and (2) strumous pyelitis, or scrofulous pyelo-nephritis.

These diseases are more common in children and below the age of puberty than in adult life; but they may occur, and more especially the “scrofulous” form of the affection, at any age. Men are said to be more frequently affected than women. Both kidneys are rarely involved to an equal degree, and the “scrofulous” form often affects one kidney only.

(1) In *tuberculous disease*, minute miliary nodules are scattered through the kidney, which is affected as part of a general constitutional malady in which other, it may be several other, organs are involved as well. These miliary nodules begin as gray granulations around the terminal branches of the arterioles which lie between the pyramids of Ferrein. These granulations infiltrate the vascular and connective tissues, and flatten the uriniferous tubes between which they occur. They are seen on the surface as small white dots, and they extend along the pyramids of the medulla, having a great tendency to spread downwards along the submucous connective tissue to the ureter and bladder, and to involve also the vesiculæ seminales, prostate, and testes.

(2) In *scrofulous disease of the kidney*—called also *strumous pyelitis*, *scrofulous pyelo-nephritis*, and the *inflammatory form of tubercular disease of the kidney*—masses of cheesy infiltration commence in the substance of the renal papillæ, and extend deeply into the kidney as well as downwards to the submucous tissue in the renal pelvis. Whether these cheesy masses are due to retrograde changes in confluent groups of miliary tubercles, or are the result of degeneration of the products of ordinary inflammation, pathologists

are not agreed; some, indeed, think that both conditions may exist at once, but that under such circumstances the tubercular take precedence of and excite the inflammatory changes. However this may be, much the same results follow. The body of the kidney is enlarged, and becomes lobulated by the extension of cheesy infiltration into the cortical parts of the organ; and, on section, conical masses of this cheesy material in different stages of softening are found to correspond with the prominences of the lobules. The pelvis of the kidney, and its ureter, are contracted by the thickening of their mucous and submucous membranes; and at a later period the mucous membrane ulcerates, and the lumen of the tube is choked by the softened, caseous or putty-like substance which escapes into it. Thus, often, both the mucous membrane lining the pelvis and infundibulum, and the secreting and tubular substance of the kidney, are affected; and the organ is converted into a huge abscess-cavity, or into a series of large irregular abscess-cavities with softened, caseous or puriform *débris* for contents. These contents readily wash away and leave exposed, white, shaggy, ulcerated walls, in which there is scarcely any, if any, renal structure traceable. In some cases, where only one organ is involved, the kidney becomes a mere shrunken, putty-like mass, in which abundance of cholesterine or calcareous nodules are formed in the lobulated spaces. This affection often has a chronic course, and certainly has a much less tendency to spread along the ureter, or to affect simultaneously other organs, than has the disseminated tubercular disease. Strumous pyelitis attacks chiefly, that is, essentially, the calyces and pyramids; whereas tuberculosis begins in the cortex and tends to spread rapidly to the rest of the urinary and genito-urinary organs.

Symptoms.—*Disseminated tuberculosis* of the kidney produces no characteristic symptoms referable to the kidney. In the early stages of *strumous pyelitis* the constitutional symptoms are not marked, and the local symptoms are absent. As the disease advances there is pain in the loin, with tenderness on pressure in the lumbar region. The urine may not be altered in quantity or character; or it may be excessive in quantity, in the early stage, and albuminous, alkaline, or acid, sometimes bloody or containing pus, minute cheesy masses, and *débris* of renal tissue, in the later stages. When it contains albumen the urine is always thick, cloudy, or opaque, and not clear as in Bright's disease; moreover, it never contains casts of the renal tubes. Occasionally there is suppression of urine, more or less complete, and then uræmic symptoms usher in the fatal termination. Often a tumor can be felt, or there is a greatly increased area of renal dulness; and if the disease be on the left side, the spleen may be so much pushed forward as at first sight to give the impression that the tumor is an enlargement of that organ. I have seen this mistake committed more than once; and in one instance in which there were no marked urinary changes, and in which the patient had suffered from ague, and a small ague-cake existed, the displaced spleen completely masked the large scrofulous kidney from which the woman ultimately died.

Vesical irritation in some cases has been the most prominent, and a most distressing symptom. A man was under my care, who, for weeks before his death, passed water with much pain and spasm, on an average 160 times in 24 hours. At the post-mortem examination, there was found scrofulous disease of the kidneys and ureter, but the bladder was quite unaffected.

In the advanced stages, there are marked rigors and exhausting sweats, or hectic. The temperature may be such as is seen in ague or hectic, or there may be intermittent periods of high fever, lasting for two, three, or four consecutive days, and followed by as many days of slightly elevated but not pyrexial temperature. Unless a tumor exists, or the characteristic cheesy *débris* is found in the urine, it is difficult, if not impossible, by the symptoms alone,

to distinguish serofulous disease of the kidney from pyelitis or pyelo-nephritis from any other cause.

Treatment.—The treatment consists in alleviating pain and improving the general health. Anodyne applications to the loin and lumbar region, and anodynes guardedly administered internally, together with cod-liver oil, bark, cream, or “maltine,” and good, bland, nutritious diet, must be employed. If the kidney has been converted into an abscess-cavity, or suppuration has been set up in the perinephric cellular tissue, nephrotomy should be performed, and the cavity well irrigated and drained. Nephrectomy in *tuberculous* disease, in which the affection of the kidney is but a local manifestation of a constitutional disorder, would be useless even if the other kidney were sound. When, however, the *serofulous* disease is limited to one kidney, nephrectomy promises much as a means of prolonging life by freeing the individual from a fatal malady.

SYPHILITIC KIDNEY.—Syphilis is now admitted to be an unquestionable cause of renal disease, though our knowledge of the precise effects of syphilis on the kidney is not yet perfectly accurate. There are three forms in which the kidney becomes involved: (1) Chronic or subacute interstitial nephritis, followed by atrophy of the kidney; (2) the formation of gummata, which are found only in a late stage of syphilis; (3) amyloid degeneration. Either the simple interstitial, or the gummatous form of inflammation may lead to cicatricial scars or puckerings on the surface, or in the cortical substance of the kidney, and to the consequent destruction of the tubules within the affected areas. Probably the atrophy which often follows interstitial inflammation is produced by arterial obstruction, resulting from the thickening of the walls of the arterioles of the cortical substance with inflammatory exudation; in this way the lumen of the vessels may be quite occluded. In support of this view may be mentioned the fact that there are sometimes seen patches of white or reddish-white color and granular appearance, resembling infarcts, surrounded by zones of congested tissues. Though gummata in the kidney are admittedly rare, they are recorded by Lancereaux, Klebs, Moxon, Greenfield, and others. Morell Mackenzie also has recorded a case of gummata in the liver and right kidney, in which the renal capsules were adherent.¹

Symptoms.—The symptoms are much the same as those of Bright's disease, but with the addition of a syphilitic history and the evidence of a syphilitic cachexia. Albuminuria of temporary or persistent duration, and in slight or well-marked degree; fatty or granular casts of the renal tubes; headache; loss of appetite and color; nausea; œdema of the conjunctiva, eyelids, and ankles; and a gradually increasing sallowness of the complexion, are the common symptoms. Death may occur suddenly from uræmic poisoning; and Dr. Coupland has pointed out² that a feature common to all cases of late hereditary syphilis, and indeed to most cases of advanced syphilis, is the occurrence of death from parenchymatous nephritis. He records two cases of hereditary syphilis in which this change in the kidney was well marked, and was quite independent of lardaceous disease. Dr. Coupland has also recorded a very rare case of infantile syphilis,³ in which a female child died at the age of three months from the impairment of the heart's action, due to infiltration of its muscular tissue with syphilitic new growth; there were also gummata of large size in the liver, and the kidneys—which to the naked eye presented a normal appearance—showed, under the microscope, in their cortical parts, an interstitial infiltration of small, round cells, most abundant around the

¹ Trans. Path. Soc. Lond., vol. xxii. p. 33.

² Ibid., vol. xxxi. p. 380.

³ Ibid., vol. xxvii. p. 303.

arteries, and especially around the Malpighian bodies; the renal epithelium was unchanged.

Prognosis.—Though serious, the prognosis is not unfavorable as regards life, if proper treatment be employed in good time, unless, indeed, amyloid degeneration have taken place.

Treatment.—The treatment consists, as in other forms of visceral syphilis, in the internal administration of iodide of potassium, alone or combined with the solution of bichloride of mercury (liq. hydrarg. perchloridi); from five to ten grains of iodide of potassium, with one drachm of the solution of the bichloride [containing $\frac{1}{16}$ grain] in a little bitter infusion, or in an ounce of water, three times a day, is a favorite form of mixture for constitutional syphilis.

AMYLOID KIDNEY.—Amyloid, waxy, or lardaceous degeneration of the kidney (*leucomatosis*) is one of the recognized forms of Bright's disease. It is a chronic affection caused by two classes of causes, viz., syphilis and suppuration. Of the various causes of suppuration, phthisis and caries of bone are the two most prevalent forerunners and producers of amyloid kidney. Amyloid degeneration of the kidney consists in a retrograde metamorphosis of the Malpighian bodies and small arteries, the glomeruli and arterioles becoming prominent and glistening; ultimately the basement membrane is affected, and transudation into the tubules takes place. Thus the appearances of the kidney differ in different stages of the degeneration. In the first stage, the organ looks almost natural in size and color, and in relation to its capsule as well as on section; but on the application of iodine or methylaniline, stained dots appear radiating from the base of the pyramids towards the capsule, and indicating the presence of degenerated glomeruli. In the second stage this degeneration is associated with secondary changes in the tubules, and the whole organ is enlarged, having a smooth, pale appearance on section, with cortical substance increased in thickness and of a dense consistence. Many of the tubules are blocked, and the application of iodine or methylaniline produces the characteristic reaction. In the third stage the kidney is atrophied, the cortical substance is relatively diminished, irregularly pitted on the surface, and of a yellowish-white, granular or striated appearance. On applying iodine, there is but slight change in the cortex, but the apices of the papillæ give the reaction well marked—brown lines extending upwards along the pyramids. This arrangement of the pigmentation is due to staining of vessels and tubules, whilst the absence of staining in the cortex is due to the breaking down of the lardaceous deposit, and to the destruction of many of the tubules. In none of the stages of amyloid degeneration is the capsule adherent, but other diseases of the kidneys in which adherent capsules are found (as, for instance, syphilis) may be associated with the amyloid degeneration.

The conditions in which the kidneys may be found, as a result of this affection, are simple amyloid degeneration, enlargement from transudation, and atrophy; these are the three stages indicated above.

Symptoms.—The commencement of this disease is gradual, and not marked by renal or urinary symptoms. Indeed, it may advance to a considerable extent, and yet not be discovered unless specially sought for. When, however, a patient with syphilis, phthisis, caries, necrosis, or any other cause of long-standing suppuration, passes a large quantity of light, limpid urine of low specific gravity, amyloid disease of the kidney should be suspected. The quantity of albumen contained in the urine is at first small, but it increases with the disease until at length one-fifth, one-third, or one-half albumen is present. In the later stages, hyaline casts are found. The urea and other

constituents are seldom interfered with. Though there is no dropsy or ascites, other organs, and especially the liver and spleen, share in this degeneration, and, as a rule, but not invariably, these organs are more advanced in the morbid changes than the kidney. The complexion of a person who is the subject of amyloid viscera becomes waxy or pasty, the strength is wasted, the flesh is lost, and the blood is impoverished, so that the white corpuscles are increased, as they are in cancer and other wasting disorders, while it becomes, too, more watery.

As a rule, the cause of the amyloid change is also the cause of death before the amyloid affection is itself sufficiently advanced to prove fatal; but in exceptional instances death occurs from anæmia, or uræmia, brought on by the amyloid degeneration of the kidney and other organs combined. On the other hand, if the cause of the amyloid changes is removed, as by amputation, excision of a joint, etc., it is remarkable how soon and to what a degree the morbid processes recede, and the organs return to something like their natural perfectness.

Besides the liver and spleen, the bloodvessels of the gastric and intestinal mucous membrane, and the lymph-glands, are frequently the seat of amyloid changes; and the serous membranes are prone to become inflamed.

Treatment.—The most important indication is to remove the cause of the degenerative changes. Hence, if syphilis exists, it should be treated; and if suppuration is going on, it should if possible be arrested. Thus caries and necrosis, joint-disease, and fistulous communications with deep-seated abscesses should be dealt with, and if possible cured. In not a few cases the albumen in the urine will disappear, and the enlarged solid abdominal viscera will shrink to a normal size, after the cause of suppuration is efficiently removed.

TUMORS OF THE KIDNEY.—The kidney is liable to many morbid new growths of a cystic and solid character, both benign and malignant. Several of these, however, do not attain to any size, nor cause the kidney to become appreciably if at all enlarged. Thus, *adenoma*, which occurs in two forms in the kidney—the papillary and the alveolar—is usually the size of a hazel-nut, or walnut, but seldom, if ever, as large as an egg or small orange; *angiomas cavernosa*, though distinct formations or new growths of reticulated cavernous tissue, are of quite small size, not exceeding that of a marble, and though called tumors, the parts which they affect are often shrunken, rather than projecting or enlarged; *leukæmic tumors* are small, scattered, roundish patches of lymphoid cells, following the course of the capillary vessels, and looking not unlike extravasated white blood-cells, though they are sometimes actively growing tumors of a truly malignant character; *lymphadenoma* is found in the kidney, associated with similar disease of the glands, liver, and intestine; *fibroma* occurs “in the form of small white knots of fibrous tissue, near the bases of the pyramids” (Moxon), but occasionally, in the kidney, there has been found a very large, simply fibrous tumor; *villous papilloma* occurs in the pelvis of the kidney, as it does in the urinary bladder, and in a case met with in the post-mortem room of the Middlesex Hospital there were villous growths in the kidney and bladder of the same person; *syphilitic gummata* occur occasionally, but do not attain such a bulk as to greatly increase the dimensions of the kidney; various sized and numerous *cysts*, as in granular kidney, are present, without adding to the size of the organ.

Though pathologically of the nature of “tumors,” most of the above-mentioned new formations never, others only rarely, give rise to tumors clinically speaking.

Clinically, any enlargement of the kidney which can be detected by physical examination at the bedside, is spoken of as a tumor of the kidney. Some

of these enlargements have been already considered, namely, the hydatid and other large cystic tumors, and the enlargement of the kidney caused by scrofulous disease. There remain, however, other renal tumors for description, namely, carcinoma, sarcoma, and rhabdomyoma—all of the nature of malignant new growths—and two which are not new growths at all, namely, hydronephrosis and pyonephrosis.

HYDRONEPHROSIS is a mechanical result of obstruction to the outflow of urine from the pelvis of the kidney; and in the most extreme cases the seat of obstruction is generally the ureter. It consists in dilatation of the pelvis and calyces of the kidney by urine, and in more or less atrophy of the renal substance, followed by expansion of the capsule, and of what remains of the cortical and medullary substance of the organ. The tension exerted by the accumulating urine stretches the calyces, and flattens and wastes the pyramids, to such an extent that the calyces are converted into huge spaces, or sacs, jutting off from the dilated pelvis, and separated from one another by slender septa formed by the wasted "columns of Bertini."

In some instances of hydronephrosis, the degree of distension is such that a tense, irregularly rounded tumor occupies the renal region of the abdomen, and expands upwards to the costal margins, downwards to the iliac crest, and inwards as far as, or beyond, the median line, whilst it also bulges backwards into the loin. In exceptional cases, the tumor attains such a size as to distend the whole abdomen, and to assume the appearance and physical characters of an ovarian cyst. Several mistakes in diagnosis have been made in such cases, and operations undertaken as ovariectomies have either had to be abandoned, or have ended in the removal of the affected kidney. In other cases, again, the tumor has an intermittent existence, being prominent at one time, and not to be detected at all, at others.¹

Causes.—Anything which obstructs the flow of urine from the kidney may cause hydronephrosis, but the largest tumors are formed when the source of the obstruction produces its effect gradually, and the obstruction becomes complete by slow degrees. A calculus impacted in the ureter, a new growth in the bladder blocking the vesical orifice of the ureter, a cicatricial or congenital contraction of the ureter, valve-like folds of the mucous membrane of, and convolutions or twists of the ureter, and the pressure of any tumor, of a pregnant or retroverted uterus, or of a hydatid cyst, or in fact any cause of external pressure upon the ureter will give rise to it.

Stricture of the urethra, cancer of the uterus or bladder, and other causes which affect the flow from both kidneys, produce hydronephrosis and pyonephrosis, but do not often cause distension of either organ to a sufficient degree to form an abdominal or even a lumbar swelling. Cancer of the uterus and vagina is a very common and fatal cause of hydronephrosis and pyonephrosis, but the degree of distension is not often great. The fluid contained in hydronephrotic cysts is limpid, opalescent, and imperfect urine, of a yellow, or, it may be, of a light-brown or light-red-brown color. Uric acid, urates, and oxalate of lime may be found in it. Sometimes the fluid is turbid, and contains muco-pus; sometimes there is blood-clot of old or recent date, which gives a brown or red color to the fluid. But in many cases the fluid is odorless, gives no reaction with heat or nitric acid, or with cupric tests, has a low specific gravity, leaves scarcely any residue on evaporation, and gives no evidence of urea or uric acid: in fact, it is only water holding a large quantity of chloride of sodium in solution, and containing a few epithelium cells.²

¹ Med.-Chir. Trans., vol. lix.

² Ibid., p. 253.

Symptoms.—When the dilatation is insufficient to give rise to a tumor, there are no symptoms of hydronephrosis; it is simply a silent complication or consequence of some other condition to which the attention of the physician or surgeon is not called by any signs. When a tumor is formed, however, it has to be dealt with as a disease in itself, especially when it threatens to damage neighboring organs by its pressure, or to destroy life by bursting into the peritoneum. The tumor is sometimes irregular or lobulated, and frequently fluctuates; if it intermits, its subsidence is followed by the discharge *per urethram* of a large quantity of urine of low specific gravity, or having pus, or mucus, or blood in it. By its size it may cause much pain, and may interfere considerably with the action of the colon, thus inducing constipation. If it arises from some innocent and painless cause, its development will be unattended by any constitutional or local disturbance; but if from some painful cause, such as a renal calculus, the attacks of colic and other symptoms incidental to the particular cause will occur before the tumor makes its appearance.

Diagnosis.—The diagnosis of hydronephrosis from pyonephrosis and perinephric abscess is often excessively difficult, and in some cases cannot be made. Perinephric abscess causes fulness in the loin, and tends to spread upwards and downwards, but does not usually present a circumscribed, more or less movable tumor, coming forward in the abdomen, and felt as the patient lies on his back to be passing beyond the median line in front. In perinephric abscess there is often œdema and redness of the skin of the loin; in hydronephrosis this is very rarely the case, and only when the tumor has reached a great size.

In hydronephrosis, redness and superficial fluctuation are sometimes felt at a spot on the side or towards the front of the belly; in perinephric abscess the matter may burst at or below Poupart's ligament, but is not likely to point higher up in front. Pyonephrosis is indistinguishable from hydronephrosis, except when there have been rigors, feverishness, or other indications of suppuration, which in many cases of pyonephrosis are wanting. Hydronephrosis may suppurate quietly and thus become transformed into pyonephrosis.

Hydatid cysts, serous cysts of the liver, spleen, or kidney, and ovarian cysts, are to be distinguished by the clinical history of the cases; and ovarian tumors, as a rule, can be excluded by the direction of the growth of the tumor, by the relation of the colon—which is behind an ovarian, but in front of a renal tumor—and by the negative results of a vaginal and rectal examination. In ovarian cysts, the diagnosis will generally be assisted by some history of catamenial pain or irregularity; in renal tumors, by some urinary interference or change, at some period or other shortly preceding the formation of the tumor. A caution is requisite respecting the relation of the colon; occasionally, and especially when the tumor grows to a great size, the colon gets behind the bulk of the renal tumor; as a rare occurrence, a portion of intestine has been found in front of an ovarian tumor.

The *prognosis* of hydronephrosis depends much upon the cause of distension, but chiefly upon whether one or both organs are involved. If only one kidney is affected, and the other does duty for both, life may be prolonged, provided that relief from the distension of the tumor is afforded. Otherwise, death will result from the effect of pressure on neighboring organs, from rupture into the peritoneum, or from suppression of urine, or uræmia. In most cases where the distension affects both kidneys, the cause of the hydronephrosis kills the patient.

Treatment.—Aspiration should be employed when there is any reasonable ground for believing that the cause of obstruction is temporary, and that

re-accumulation is not likely to occur. Kneading the abdomen has been successful when the tumor has been the result of convolution and sacculatation, here and there, of the ureter; it might also succeed when the cause of obstruction was a small calculus or a retroflected uterus; but it is a measure which must be resorted to with extreme care, for fear of rupturing a tense, and perhaps softened or thin-walled tumor. If the cause of obstruction seems permanent or progressive, nephrotomy and drainage should be employed, and then, if the obstruction is subsequently removed, the fistula may be allowed to close; and if the obstruction is permanent, the atrophied renal substance may cease to secrete, or may become destroyed by suppuration, and thus the fistula will be healed. If a permanent fistula results, nephrectomy should be performed if the patient cannot or will not bear the discomfort and inconvenience of the fistula. This inconvenience can be minimized, however, by a simple apparatus fitted to the loin to catch and contain the urine.

Pyonephrosis.—Pyonephrosis, or dilatation of the kidney with pus, or pus and urine, is like hydronephrosis a mechanical result of obstruction, but it is something more. In pyonephrosis there is pyelitis as well as dilatation of the pelvis and calyces: there is inflammation of the mucous membrane of these parts, superadded to the mechanical distension and its results. In advanced cases the inflammation and suppuration extend beyond the calyces, and go on to the breaking down of the medullary and cortical substance, until at length the whole kidney is a largely dilated sac of pus.

A suppurating hydronephrosis is a pyonephrosis, and therefore the same causes which produce the one may give rise to the other; but, as a rule, the obstruction which at once causes pyonephrosis is more rapidly complete, and is thus attended by more irritation to the kidney than that which causes hydronephrosis. The organ has not time to go on gradually dilating and gradually atrophying whilst the other kidney *pari passu* is taking on compensatory hypertrophy; but inflammation is at once or very shortly lighted up by the same cause which checks the outflow of the urine. In one form of the disease, the cause of the inflammation is necessarily the cause of the obstruction: in those cases of strumous pyelitis where the pelvic mucous membrane is most affected, the entrance of the ureter becomes blocked by the inflammatory swelling—possibly by the swelling about an ulcer there; dilatation of the pelvis and calyces follows, the whole of the kidney-tissue is compressed, the pyramids are at the same time the seat of the serofulous inflammation, and gradually the kidney is transformed into a large cyst filled with pus, with ragged, tubercular, suppurating tissue lining it.

In suppurating hydronephrosis, the pus and urine may be found in very different proportions in different cases.

Diagnosis and Treatment.—When the constitutional symptoms of suppuration, or the symptoms of pyelo-nephritis, are followed by a renal tumor, the *diagnosis* is fairly easy; otherwise it is impossible to distinguish hydronephrosis from pyonephrosis. This uncertainty, however, is of little consequence, as the *treatment* is the same in either case, except that where the fluid is purulent, nephrotomy and drainage through the loin should be at once resorted to without temporizing with the trocar. Nephrotomy has many times been performed in pyonephrosis, with advantage, and in some instances with completely successful results. On introducing the finger or fingers into a hydronephrotic or pyonephrotic kidney, through the incision in the loin, a large, lobulated or pouched cavity will at once be detected. Such a cavity will not be found in a perinephric abscess. The cavity is often far too large to allow of the finger reaching the orifice of the ureter, so that even

if a stone be impacted there, it may not be discovered till the cyst has discharged for some time and has shrunk.

Abscess in the kidney is not to be confounded with pyonephrosis; it occurs in one form of surgical kidney, in pyæmia, and in scrofulous disease of the organ; but it never causes much enlargement in the first two conditions, and not frequently in scrofulous disease, unless the whole kidney is affected.

SOLID TUMORS OF THE KIDNEY.—Carcinoma, sarcoma, and myo-sarcoma or rhabdomyoma, occasionally occur as primary new growths in the kidney. Carcinoma is much more frequently secondary than primary. Injury and the irritation of calculus have, in several recorded cases, been the cause of primary cancer. Secondary carcinoma has, in quite a considerable number of cases, been preceded by carcinoma testis; in other cases, it follows cancer of the liver, stomach, breast, or uterus, etc. As a primary disease, it affects one organ alone; as a secondary disease, usually both kidneys are involved. It occurs as a primary disease in children before the fourth or fifth year; and in adults in advanced life. As a result of stone or laceration, it has caused death at the age of twenty-five. Though rapidly causing death after it has once commenced, it may require a long time before it is excited into existence: thus twenty years have elapsed between a fall which gave rise to a renal calculus with a blood-clot for its nucleus, and death from primary cancer of the kidney in which the calculus was situated.

All forms of cancer have been met with in the kidney, but either the medullary or scirrhus are the most common, and medullary cancer is much more common than scirrhus. That which attains the greatest size is the medullary when it attacks children. Colloid of the kidney is met with, like tuberculosis and carcinoma, as part of a general infection of the system.

Cancer begins either in the fibrous stroma of the cortex, or in the epithelium of the renal tubes. Frequently, however, the proper tissue of the kidney is invaded by a cancer, which has had its primary seat in the lymphatic glands or other structure about the hilus, and the disease, putting on the form of the kidney after penetrating the hilus and expanding the capsule, is called, a "renal" cancer. Moxon thinks this the commonest plan of attack in primary renal cancer, and as it may be long before the renal pelvis is penetrated, and as the proper renal tissue remains long intact, we have, he says, the reason of the frequent absence of diseased products in the urine. The whole organ in time becomes infiltrated, and when the disease begins within the capsule this process is very rapid; and cysts and bloody or purulent collections form in the organ as the disease advances. There is nearly always a tumor recognizable during life. The tissues around the kidney, too, become adherent to the organ, and sometimes the cancer advances outwards until it is immediately beneath the skin in the loin.

Symptoms.—The presence of a tumor in the loin, is almost a constant symptom in renal carcinoma. This tumor, though sometimes tender, is, as a rule, painless, until by its increased dimensions it exercises severe pressure upon surrounding structures. The pain radiates far and wide, and perhaps increases paroxysmally; œdema, constipation, and vomiting, and jaundice if the right kidney is the seat of disease, are frequently present. Hæmaturia is not seldom noticed before a tumor; in some cases it is slight, or altogether absent; in others it is severe. Sometimes clots of blood partially block the ureter for a time, and then, after all the coloring matter has been washed out of them, are passed *per urethram* as colorless, fibrinous shreds or columns. As a rule, the urine offers no indication of the nature of the tumor; but occasionally, not only blood or coagula, but small cancerous masses are voided.

The *diagnosis* has to be made, first as to the seat of the tumor, secondly as to its precise nature. The exact locality of the tumor when first seen, its direction of increase, and the line of surrounding dulness or resonance on percussion, will help to fix the renal origin of the swelling, as distinct from an origin in the liver, spleen, or ovary. But errors in this respect are sometimes unavoidable, and I have found, on post-mortem examination, a large cancer in the kidney of a man who had been supposed by some most capable diagnosticians to be the subject of a liver-growth. Similar errors as to the spleen, when the left kidney has been the seat of cancer, are on record. The rapidity of growth of the tumor, its unequal resistance and nodular outline, and the progressively cachectic aspect of the patient, point to cancer; and when a swelling, which has begun on one side of the abdomen and in the renal region of a person either below the age of five or over that of sixty years, rapidly attains a very large size, its cancerous nature may be diagnosed with fair certainty. Whether in children or adults, it is a common thing for these tumors to reach a weight of eight or nine pounds, and upwards.

From enlarged mesenteric glands, renal cancer is distinguished by its one-sided position and less nodular outline; from cancer of the colon or small intestine, by the absence of characteristic intestinal symptoms.

The aspirating needle will furnish negative evidence, and will show that the tumor is due to one of the forms of solid growth, as distinct from cystic. It can do no more. The progress of cancer of the kidney is very rapid; from eight or nine months, to one or two years, according to the situation in which the growth has originated, is the usual duration of life after the commencement of the disease.

Treatment.—This can only be palliative in the middle and later periods of the disease. In the very early stage, could the growth be recognized then, nephrectomy would seem to offer a prospect of postponing the fatal result, perhaps even of considerably prolonging life.

Sarcoma sometimes forms in the kidney, and attains a formidable size, though it is also met with of a size not larger than a walnut. In one specimen in the Middlesex Hospital Museum, such a growth occupies the renal pelvis, together with a large, branched calculus; but the kidney is not at all increased in dimensions. When of large size, renal sarcoma resembles carcinoma clinically.

Rhabdomyoma.—Cases of renal tumor of probably congenital origin, and composed of striped muscle and sarcoma-tissue, have been recently recorded by German and English pathologists. These tumors have been removed after death from infants of from six to eighteen months old. In some instances there has been a tumor of each kidney; in some all vestige of normal kidney-structure has been destroyed; in others the tumor has lain beneath the renal capsule upon the surface of the kidney.¹

Tumors of the supra-renal capsule occasionally occur, and though, as a rule, they are too small to give rise to abdominal swelling, they sometimes are of considerable size. They are not usually associated with any marked, still less with any characteristic, symptoms. Wilks and Moxon record a case of primary sarcoma of each supra-renal body. Each capsule was greatly enlarged, and of the size of a fetal head of full term.

Primary cancer of these organs is very rare, but cancer of the supra-renal capsules, as part of a general cancerous infection, is by no means so. Averbek has collected forty-three cases. Melanotic sarcomata, malignant blood

¹ For a full account of some of these tumors, the reader is referred to Trans. Path. Soc. Lond., vol. xxxiii. pp. 312, *et seq.*

cysts, hydatid cysts, and adenomata of these parts have also been found. Moxon speaks of growths of supra-renal tissue "forming considerable tumors, say of the size of a chestnut, in or upon the supra-renal capsules." These adenomatous new growths are single in each capsule, but both capsules may be similarly affected. Virchow, who looks upon the medullary part of the supra-renal capsules as allied to nerve-tissue, proposes to group its tumors amongst the gliomata.

SURGICAL KIDNEY.—Many morbid conditions of the kidney, the results of disease of the urethra, prostate, or bladder; or occurring in cases of paralysis necessitating the use of the catheter, or after surgical operations upon the urinary organs, are grouped together under this head.

Acute and chronic interstitial nephritis, uncomplicated with pyelitis or suppuration, and with or without dilatation of the kidney; suppurative nephritis and pyelo-nephritis; and the tough, shrunken, scar-marked kidney which follows recovery from simple, acute, and chronic inflammation, are all included by authors under the term "surgical kidney." For the anatomical characters of these several lesions, I must refer the reader to works on pathology.

Stricture, prostatic enlargement, vesical calculus, chronic cystitis from any cause, and various other diseases of the urinary organs, excite these lesions in the kidney, either by mechanically obstructing the urine, or by interfering with the renal circulation—either through the agency of the nerves or by changes in the intra-renal tension—or, again, by extension along the ureter to the kidney of putrefactive changes, which have commenced in the urethra or bladder.

As the disease known as surgical kidney has often appeared to commence after a surgical operation whereby the urethra or bladder is laid open, or after the introduction of a catheter, the admission of air, or of the agents of putrefaction contained in the air, is supposed to be an exciting cause. In some cases, the suppurative inflammation which occurs in the renal tract under these circumstances is regarded as being of an erysipelatous nature, and due to the direct introduction of the poison through the catheter or operation wound. This question has been fully discussed in an able paper by my friend, Dr. Goodhart.¹ Though in the majority of cases, the acute morbid processes in the kidney can be traced to extension of inflammatory disease from the bladder upwards, yet it is certain that in some instances of chronic disease in the lower urinary organs, the acute suppurative changes which supervene in the kidney begin in that organ, and, as far as they affect the ureter or bladder, do so only by extension downwards. These cases, too, are often most severe and even fatal. I have witnessed three or four such, and have followed them throughout their course to the post-mortem table.

Symptoms.—The symptoms vary with the character of the anatomical lesions. In simple, chronic, interstitial nephritis, even when associated with extreme sacculation of the kidney, there may be no symptom referable to that organ, except the low specific gravity of the urine, and, possibly, a lumbar swelling detected on palpation. (See section on Hydronephrosis.)

In the acute or subacute forms of the disease, especially when suppuration occurs, the symptoms are more or less pronounced. They begin with a rigor, or come on insidiously with slight chills, while the temperature will rise at night to 101° or 103° F., and fall in the morning, though not quite to the natural standard. The patient becomes dyspeptic, flatulent, weak, and emaciated, with a hot and often perspiring skin, offensive breath, loaded tongue, loss of

¹ Guy's Hosp. Reports, 3d series, vol. xix.

appetite, and constipated bowels. The urine is passed in normal and often in excessive quantity, and contains mucus and pus in varying amount, with hyaline, granular, or pus casts. When acute nephritis passes into the suppurative condition, the urine becomes very offensive; pus, and often blood in small amount, are mixed with it, and renal epithelium and pus casts are sometimes found in large quantity.

When "surgical kidney" results from some obstructive condition of long standing, and comes on in persons of, or beyond, middle age, there is very generally a deficiency in the elimination of urea, so that the urine, besides the other changes noticed, is of low specific gravity. As the disease advances, the skin becomes sallow or muddy-looking, the memory and intelligence show signs of waning, the patient, though drowsy, is restless, and as the end approaches he passes into a comatose condition, but without the convulsive seizures and other marked symptoms of typical uræmic poisoning.

In some cases of surgical kidney—as, for example, when acute suppurative nephritis occurs in a kidney, the subject of hydronephrosis and chronic interstitial nephritis—the attacks of pyrexia assume an intermittent character, last a few days, and then pass off for a few days or a week; and each attack corresponds with, and indeed is a sign of the subjection of a fresh area of the kidney to, inflammation and suppuration. During the attacks, the temperature will reach 102° to 103° F. at night, and 100° to 101° F. in the morning; the pulse is quick; the appetite is lost; the tongue is dry, coated, and foul; the bowels are constipated; the skin is dry and pungent; and there is flatulent distension of the stomach and intestines. During the intervals between the pyrexial attacks, the general condition improves, and the patient is less depressed mentally as well as physically. After five or six of these feverish periods—the interval between them shortening as they recur—the patient gradually passes into a state of low continued fever, and death, partially by coma, partially by asthenia, carries him off.

In other cases the symptoms assume a pyæmic or septicæmic nature.

The *prognosis* of surgical kidney depends upon its cause and upon the character of the induced renal disease. If the cause be removable or remediable, and if suppuration in the substance of the kidney have not commenced, recovery with a more or less damaged kidney may ensue. But if the cause of the disease is irremediable, as in cancer of the uterus or bladder, or if suppurative nephritis has commenced, a fatal termination must be looked for. When feverishness follows the use of the catheter, or any operative procedure, upon a person whose kidneys have been already damaged by chronic interstitial nephritis, alarm should be occasioned; and if the feverish symptoms continue, or intermit, an evil ending may be expected.

Treatment.—Prophylactic treatment is most essential. The cause of the obstruction to the outflow of urine should be removed if possible; and if this is not possible—and in many conditions, as, for example, in enlarged prostate, it is not—the employment of the catheter to prevent distension by retention of urine, and irrigation of the bladder to obviate the ill consequences of putrefactive changes in the urine and mucous secretion, should be had recourse to early. At the same time, care must be exercised against the risk of introducing any source of poison with the catheter; and to this end the instrument should be kept scrupulously clean, and before its introduction should be anointed with pure white vaseline, or with carbolized oil or glycerine (1 part in 16); and it should not be used by any one who is at the same time visiting infectious cases, except after carefully changing his clothes and disinfecting himself. By neglect of these precautions, there is reason to believe that poison has been conveyed from an erysipelatous or scarlet-fever patient, or from one with whitlow or some offensive wound, to another who, without organic disease

of his urinary organs, has happened to require the use of the catheter at the hands of the same medical attendant that was attending the infectious patient. After the performance of any surgical operation upon the urinary organs, the patient ought to be placed in the best possible hygienic surroundings, and the same care should be used in keeping the wound clean, and in preventing putrefaction in and about it, as is exercised when the thorax or abdomen is opened, or a joint cut into or excised.

For the rest, the treatment consists in keeping the bowels open freely, and in assisting the digestive organs in the discharge of their functions. This is well done by a pill of three grains of extract of colocynth, half a grain of blue pill, and one and a half grains of Dover's powder, given every night; and by a diet consisting largely of milk, and milk and farinaceous puddings, a little fish, and good broth, beef-tea, or chicken-*purée*. Stimulants must be avoided, or given only in such quantity and in such form as will assist digestion. The action of the skin should be assisted and stimulated by warm clothing, by a regular and regulated temperature of the apartment occupied, which should be from 60° to 65° F., and, if necessary, by vapor baths, or by increased doses of Dover's powder.

OPERATIONS ON THE KIDNEYS.

In describing the operations performed upon the kidney for the relief or cure of what may now be called the "surgical" diseases of the kidney, I shall consider each under the following heads: What is the operation done for? How is it done? And what are its dangers?

The term "surgical diseases of the kidney" is used advisedly, because there are, and from their pathological character must always be, certain affections of those organs—such as the various forms of degeneration of the secreting structure, fatty, granular, cystic, and amyloid—which are not appropriate for any surgical treatment; and there are others, such as tubercle and cancer, which are but doubtfully fitted for it.

But the time has forever gone by when the words with which "dear old Lawrence" (to quote from a letter by a physician who had been his pupil) used to begin one of his lectures, namely, "the kidney, gentlemen, is fortunately beyond the reach of the surgeon," will find a single echo of assent.

Besides the use of the trocar or aspirator, there are four surgical operations which are now generally recognized, and which have been frequently performed upon the kidney; and the lives of many patients have been saved by them, whilst comfort and relief from great suffering have been afforded by them in many other instances.

The names given to these operations are sufficiently expressive of their objects and characters:—

1. *Nephrotomy* (νεφρός, kidney, τέμνω, I cut) is an incision into the kidney for purposes other than the extraction of a calculus, though it is quite possible that a calculus or calculous material may be removed after such an incision has been made. Thus on laying open an abscess of the kidney, one or more calculi may be detected lodged within the pelvis or calyces of the organ; or having ulcerated its way through the kidney, the stone may be found lying outside the suppurating organ.

2. *Nephrolithotomy* (νεφρός, kidney, λίθος, stone, τέμνω, I cut) is an incision into the secreting substance or pelvis of the kidney, with the express purpose of removing a calculus therefrom; and that too at a date in the progress of the disease prior to the disorganization of the renal substance, or the conversion of the renal pelvis into a large abscess-cavity. This operation is of quite

recent origin, and was, I believe, first performed by myself;¹ and when publishing the case in which I had employed it, I supposed that I had also for the first time proposed the name by which I had designated it. M. Hévin, however, in his exhaustive historical and critical researches upon nephrotomy, informs us that Schurigius,² in speaking of the proposal to perform the same operation, had called it *la néphrolithotomie*. But M. Hévin arrived at the conclusion that it was well nigh if not absolutely certain that cutting the kidney for stone had never been performed except in cases in which an abscess-tumor, or an external fistula, was present in the loin.³

The name however seems to have been quite lost, and the proposed operation had been "magisterially exploded"⁴ by modern as well as ancient surgical authority, as may be seen by perusing the works of the writers whom I have quoted in the article above referred to.

Nephrectomy (νεφρός, kidney, ἐκτέμνω, I cut out) is the complete removal of a kidney, either through an opening in the loin or by abdominal section.

Nephrorrhapty (νεφρός, kidney, ράπτω, I sew), consists in cutting down upon and exposing the kidney, and then stitching it to the edges of the wound in the parietes. It is undertaken with the object of fixing a floating or movable kidney.

PUNCTURING THE KIDNEY.—This may be done with a trocar or with an aspirator. It is performed for the relief or cure of hydronephrosis and pyonephrosis; large, isolated, serous or blood cysts of the substance of the kidney; and hydatid cysts. When from their degree of distension such swellings are causing serious consequences of pressure, or when there is risk of the cyst-wall rupturing, the contents ought to be evacuated.

The point selected for puncturing will depend on circumstances. If there be any spot over the swelling which is thin, soft, prominent, or fluctuating, the trocar should be there inserted. A point which is not seldom indicated is midway between the umbilicus and the anterior superior spine of the ilium, or half an inch below and an inch and a half to the side of the navel. When no particular spot is suggested by discoloration or prominence, no better place can be selected, on the left side, than an inch in front of the last intercostal space; but if the tumor be of the right side, this is too high, as the liver would be traversed. On the left side, the spleen, under ordinary circumstances, runs no risk of being punctured by inserting the needle well in front of the eleventh intercostal space, and if the spleen be projected forwards by the tumor, as I have sometimes seen it, it will be detected in its abnormal position by palpation, and must of course be avoided. "If there be no indication for operating elsewhere, I think the best spot to select, when the tumor is of the right kidney, is half way between the last rib and the crest of the ilium, between two and two and a half inches behind the anterior superior spine of the ilium. This spot is on a level with the front of the bodies of the lumbar vertebra, and a needle here passed horizontally inwards will be altogether in front of the kidney. It may, however, with safety be conjectured that, in any case of hydronephrosis of the right side *requiring to be tapped*, if the trocar be inserted at this place and directed somewhat forwards, the peritoneum and colon will be sufficiently in front to escape injury, the liver will be safely out of reach above, and the kidney behind, while the dilated pelvis of the kidney will be tapped at its anterior and lower part."

¹ Trans. Clin. Society, vol. xiv. p. 30. London, 1881.

² Litholog. Hist.-Médic., cap. 13, par. i. 1720-32.

³ Sur la néphrotomie, ou taille du rein. Mémoires de l'Académie Royale de Chirurgie, t. iii. p. 262. Paris, 1819.

⁴ See Bernard's account of Marchetti's operation. Philosophical Transactions, vol. xix.

These remarks are taken from a paper on "Intermitting Hydronephrosis," published by myself in 1876, and are based on numerous experiments, some of which are there recorded.¹

In performing the operation, the aspirating trocar should be inserted without any previous incision of the skin; if a larger trocar be used, an incision through the integument and muscles is sometimes made before introducing the instrument.

The dangers of the operation are very slight. If the puncture be made too far forwards, and through a non-adherent peritoneum, some of the contents of the cyst may be extravasated into the peritoneal cavity on withdrawing the canula—an accident which has proved fatal in more than one case. There is also the danger of wounding the intestine, which, as a rule, is in front of and adherent to the tumor, and if the trocar be long, or be thrust too far inwards, it may penetrate some important bloodvessels, and cause dangerous if not fatal hemorrhage. The penetration of the thin edge of the liver with an aspirating needle, though to be avoided, is not an accident likely to be followed by any ill consequence. The instrument should not penetrate too near the ribs, for fear of wounding the pleura.

NEPHROTOMY is performed for hydronephrosis when the cyst refills rapidly after having been punctured; for hydatid cysts under similar circumstances, or when from the number and size of the daughter-cysts the contents cannot be evacuated through a small tube; for pyonephrosis; and for any case in which the kidney has been converted into an abscess-sac, whether from the presence of calculus or tubercle.

The incision is precisely the same as for lumbar colotomy, except that, as the kidney is situated a little nearer the median line than the colon, the deep part of the wound should be kept a little posterior to that of colotomy. A slight oblique incision should be made in the costo-iliac interspace, beginning over the outer edge of the erector spinæ muscle, and continued forwards for three and a half inches. After dividing the skin, superficial fat, and fascia, the outer border of the latissimus dorsi, and the posterior border of the external oblique of the abdomen will be brought into view, and should be divided to the full extent of the superficial incision. It is unnecessary to open the sheath of the erector spinæ. Next, the internal oblique and the aponeurosis of the transversalis must be cut through, whereupon the outer border of the quadratus lumborum will be seen, and the deep layer of the lumbar aponeurosis must then be divided. No grooved director or other guide will have been necessary up to this stage, a scalpel and a pair of dissecting forceps for the operator, and two well-formed, deep retractors for his assistant, being all the instruments required beyond two or more pairs of torso-pressure forceps to control hemorrhage from any vessels cut in the division of the parietes. The peri-renal fatty tissue, having thus been reached, will, in all probability, be found condensed, and otherwise much altered, from the inflammatory process which has gone on in and around the kidney; and if the operation be done for abscess of the kidney, suppurative changes, perhaps, will have taken place in the structure forming the bed of the organ. When this tissue has been divided, the distended pelvis, cyst, or abscess (as the case may be) of the kidney should be either first tapped, or at once cut into, its contents evacuated, and the cavity well irrigated with some disinfecting solution. If it be thought desirable, as it is in hydronephrosis and cyst of the kidney, to stitch the cut edges of the cyst to the edges of the skin, this should now be done. A drainage-tube should be inserted, and the greater part of the

¹ Med.-Chir. Trans., vol. lix. p. 243. 1876.

wound left to granulate, though the anterior extremity may be brought together by one or more sutures with advantage.

The dangers of nephrotomy are not in the operation, but depend entirely upon the condition of kidney for which the opening is made. When done for cyst, hydatid or simple, the probability is that with a free drain for its contents, the cavity will soon contract, and the wound close by granulation; when done for hydronephrosis or pyonephrosis, set up by some permanent obstruction in the ureter, a continuous and persistent flow of urine, or pus mixed with urine, must ensue, and unless the fistula thus formed be removed by nephrectomy, a receptacle, into which the fluid can trickle and be retained, should be adjusted to the loin and constantly worn. Such an instrument has been made at my suggestion by Mr. Hawksley.

When nephrotomy is performed for abscess, recovery may take place; but if the kidney is completely converted into an abscess-sac, or is the seat of breaking down serofulous deposit, the patient, though benefited for a time, may be worn out at length by suppuration or hectic.

NEPHROLITHOTOMY.—This operation should unhesitatingly be done in all cases in which symptoms of renal calculus continue uninfluenced by medicinal treatment, and are sufficiently severe to interfere materially with the comfort and usefulness of the patient's life. If for several months a person has been subject to more or less constant pain in one loin, and along the ureter, and, perhaps also, in the testicle of the same side; if there have been recurring attacks of renal colic, and especially if with these symptoms there has been occasional hæmaturia, or the urine has been constantly charged with a little pus or albumen, we have the conditions not only justifying, but demanding an exploration. If, in addition to these symptoms, a small calculus, or a little calculous matter has been passed *per urethram*, there is almost absolute certainty of the presence of a stone.

Symptoms strongly suggestive of renal calculus arise, however, from causes other than stone, and many times an exploration has been made of the kidney, and nothing found to explain the symptoms. But it by no means follows that no stone is in the kidney, because none is discovered upon examination; for subsequent events have in several instances divulged the existence of calculus in a kidney, in which a stone has been searched for in vain. Moreover, the exploratory incision sometimes greatly relieves the symptoms; this has been explained by Mr. Amundale, as probably due to division of some of the nerves in the lumbar parietes. From the temporary relief which followed one of my early operations, where the kidney was very loosely placed in its surrounding tissue, I was led to think that the contraction which followed cicatrization might have caused the improvement by fixing the kidney in its place, and I was quite prepared to act on this idea in a future case by plugging the wound, and thus making it heal by granulation. Another plan of treating mobile kidneys has, however, since then been practised by Hahn, of Berlin, and will presently be described under the heading of nephrorraphy. An unlooked-for advantage, in one instance, followed the exploratory incision in the following manner: nothing was found at the operation except considerable condensation of the peri-renal tissue; the wound healed rapidly, and the patient was much relieved, but some time afterwards the cicatrix spontaneously opened, and a quantity of pus escaped; the opening then closed for a time, and the cicatrix has since then several times alternately discharged pus and closed up, but the patient has been quite relieved from all inconvenience except the occasional purulent discharge. Here it would seem that the operation-wound prepared a way for the escape of matter from

a peri-renal abscess, the antecedent inflammation of which had given rise to such severe symptoms as to lead to the exploration.

Operation.—An incision is made four and a half inches in length, parallel with, and three-fourths of an inch below, the last rib. The structures divided are the same as in nephrotomy. In nephrolithotomy, if the quadratus lumborum be so wide as to contract the deep part of the wound, its outer edge may be incised to the extent of one-half or three-fourths of an inch. All bleeding vessels having been twisted, and hemorrhage quite stayed, an assistant should stretch the edges of the wound widely apart with suitable retractors, and the operator, with two pairs of dissecting forceps, then tears through the peri-renal fat. As he approaches the back of the kidney, there will be sometimes noticed a difference in the character of this fat, that immediately in contact with the kidney being finer in texture and of a delicate primrose color. If from presence of the stone there has been inflammation in the tissues around the kidney, this appearance will not be expected, and the whole of the tissue will probably be dense and tough.

When the kidney has been fairly reached, the index finger should be passed carefully over the whole of the posterior surface of the organ, including its pelvis, and any inequality of surface, or increased hardness or resistance at any particular spot, should be searched for. During this tactile exploration—indeed, throughout the whole of the examination of the kidney—the abdominal walls of the patient should be well supported by an assistant, or by well arranged pillows, so that the kidney may not be pushed forwards by the exploring finger. If nothing suggestive of the presence of a stone is thus felt, the kidney should be freely exposed to view by drawing aside the edges of the wound, and a fine needle should be passed into the renal substance. This should be done in a systematic way, and in several places, if the stone be not at once struck—introducing the needle here and there, so as to puncture in succession the several calyces of the kidney, in one or other of which experience tells us that the stone usually rests. If in the course of the digital exploration some one spot gives more resistance than the rest, this should be first punctured, but otherwise the puncturing should be done in a well-planned manner. On this point I would lay great stress, as it is quite possible to puncture in a dozen places, and yet to miss the calculus.

If by this means the calculus is not detected, the search should not be given up until the fingers of the right hand are passed round the outer edge of the kidney, and the front surface felt over in the same way as the posterior. Whilst doing this, in order to give counter-resistance to the exploring finger, the kidney may be pressed against the *psoas* muscle, or be squeezed between the finger and thumb. Despite all these means, a calculus may escape detection. I recently removed by lumbar nephrectomy a healthy kidney for a calculus, the size of a marble, imbedded in it, but which I could not localize. The man recovered well, but the loss of so good a kidney was a very regrettable feature in the case. The kidney becomes very hard and tough under the prolonged irritation of a stone, so that, whilst the organ feels firmer than natural, any slight difference in the degree of resistance of one part is more difficult to appreciate. This hardness of the renal substance should make the surgeon very suspicious of a calculus, and future experience will, I think, encourage him, when this condition is present, not to be satisfied, either that no stone exists or that nephrectomy must be performed, until he has made such an incision into the kidney as will open each of the calyces. Kidney-wounds are known to heal readily, and whilst the risk of such an incision would not equal that of nephrectomy, the preservation of even a wounded kidney would be preferable to the sacrifice of the organ. The stone having been detected by one or other of the methods above described, the overlying part

of the kidney should be cut into with a probe-ended, straight bistoury; then, with a scooping movement of the finger introduced through the incision, the stone, unless a branched or very large one, can be raised to the surface of the parietal wound on the point of the finger. Or a pair of forceps might be passed into the kidney by the side of the knife, and the stone seized and withdrawn. The finger is, however, much to be preferred, and if the incision is small, as it ought to be, the finger serves the purpose of plugging the renal wound, whilst it lacerates the renal tissue to the necessary extent. By this plan the hemorrhage is minimized, and the rent made with the finger heals as readily as the cut. When equally convenient to reach the stone, it is much best to open the secreting structure, and not the pelvis of the kidney; a wound in the former heals better than one in the latter, and the chance of a urinary fistula is therefore much less.

If the calculus be large and branched, it may possibly be requisite to break it up into two or more fragments, and remove the fragments separately. I have known this done in a suppurating kidney, but it is not probable that a stone will attain such a size as to require breaking before removal, without having in its growth more or less destroyed the kidney-structure. A stone, one ounce or less in weight, has been removed entire from a kidney which was not markedly enlarged, nor the seat of advanced suppuration.¹

The after-treatment is very simple: a drainage-tube should be left in the back part of the wound, and the rest should be closed by sutures. For a time, of course, the whole or greater part of the urine secreted by the injured kidney will be discharged through the loin, but, after gradually diminishing, this may be expected to cease altogether in from three to four weeks. These lumbar wounds usually heal very quickly. In both nephrotomy and nephrolithotomy, some simple dressing, such as lint soaked in terebene and oil, or spread with boracic ointment, should be applied over the wound, and the drainage-tube should pass through this and be covered with a thick pad of absorbent cotton-wool, or Lister's gauze (I have used both, and with equally satisfactory results), retained in place by a light bandage. The dressings will require frequent changing, as they soon become saturated with the urine; to keep the bedding dry, a large pad of finely powdered German moss-peat should be placed beneath the loin, to receive and absorb the urine, as it readily does.

The dangers of nephrolithotomy are not great, as far as we can judge from present experience. The operation hitherto has, it appears, been uniformly successful, but the number of cases as yet recorded is but small. (1) Hemorrhage from the wounded kidney is not likely to be serious if the plan above suggested be followed. There may perhaps be a formidable-looking gush on first dividing the tissue, as in Mr. Marcus Beck's case, but compression with the finger or a sponge will soon check it. (2) Cellulitis may follow the operation, but with due precaution as to antiseptic cleanliness and drainage, this will almost certainly be escaped. It may, however, occur, and I am aware of one case in which extensive suppurative cellulitis followed an exploratory incision in search of a renal calculus; pus burrowed downwards to the pelvis, and upwards until the abscess burst into the lung, and though the patient ultimately recovered, he nearly lost his life. In this case there had been great liberty taken with the wound, and many hands had been introduced for the purpose of feeling the kidney. The kidney however was not cut into, and therefore nephrolithotomy cannot be properly charged with the complication, which was only such as might follow any deep wound in the loin, whether addressed to the colon, or kidney, or neither.

¹ Bennet May, Trans. Clin. Society, vol. xvi. London, 1883.

(3) Renal abscess may possibly follow the operation as the result of wounding an organ already long irritated by the presence of a calculus. I do not know of it having occurred, and it is much more probable that any morbid change started by the calculus would be checked and repaired by the removal of the cause—a result which is proverbially known to occur in other tissues of the body. Moreover, if such a sequela should happen, it is only what would be sure to arise sooner or later if the calculus were to remain in the kidney.

(4) A renal fistula, or a more superficial, purulent fistula, may follow, but though the chances are against its occurrence, such a result would be a welcome substitute for the ceaseless pain and chronic invalidism of the condition which it would replace.

NEPHRORRAPHY was first performed by Dr. E. Hahn,¹ of Berlin, though the experience of others, including my own, had quite prepared us to accept some such operation as a distinct step in the treatment of wandering kidney. It is practised in cases of floating, movable, or wandering kidney, in which the organ, besides being mobile, is the seat of frequent severe and spasmodic attacks of pain, or of more or less continuous suffering.

The operation consists in fixing the kidney in the loin, and is performed by exposing the organ through a lumbar incision such as that described for nephrotomy and nephrolithotomy. This done, a strong catgut suture should be passed through the renal capsule and the edge of the parietal wound. By tightening and knotting this suture, the kidney is fixed back against the lumbar parietes. The wound should be stuffed with carbolic gauze, or boracic lint, and left to heal by granulation. The operation has been performed several times by Küster, Esmarch, Bassini, David Newman,² and others, and with almost uniform success. In one case, however, Gilmore found that the suture cut its way out of the kidney and set the viscus once more free; he afterwards successfully removed the kidney by lumbar nephrectomy. Dr. Robert F. Weir, in fixing the kidney of a woman aged thirty-three, cut along the outer edge of the quadratus lumborum, from the last rib to the iliac crest, thus making a longitudinal instead of an oblique incision, and stitched the peri-renal fat to the edge of the external wound, leaving this open to fill by granulation. The patient did well, and was greatly improved by the operation. Hahn also made a longitudinal incision, and in his first two cases simply stitched the peri-renal adipose tissue to the parietes by eight or ten catgut sutures; but as the result in one of these cases was not quite satisfactory, he passed the catgut suture in his third case through the renal capsule. Hahn advises that the kidney should be fixed as low down as possible, so as to obviate the effects of dragging when the patient resumes the upright posture. Experience will have to decide whether there is any necessity for penetrating the envelope of the kidney. Gilmore's case shows that the same want of success may follow from the renal as from the peri-renal suture. Indeed, though a suture seems to give an extra chance of success, and adds but little extra risk to the lumbar incision, it is not yet adequately proved that any suture is requisite to attain the end in view. Before the publication of Dr. Hahn's paper, I had advocated the lumbar incision alone as a probable cure for movable kidney, and I had attributed the relief which followed in a case in which I had made an exploratory incision, to the retention of the organ in its place by the contraction and adhesion resulting from the wound. The surgeon must, however, look to the future to decide these and many other questions relating to the surgery of the kidney.

¹ Centralblatt für Chirurgie, 23 Juli, 1881.

² Brit. Med. Journ., April 28, 1883.

Of course no operation should be undertaken for a floating kidney until pads and belt, and corsets, for steadying the kidney, and electricity, massage, and sea-baths, to increase the tone of the abdominal parietes, have been tried and failed; but fail in severe cases they almost certainly will do. The dangers of nephrorraphy are the same as those of nephrolithotomy, except that there is little or no hemorrhage from the kidney on introduction of the suture.

NEPHRECTOMY, or the removal of the kidney from the living body, was first performed as a planned operation in the human subject by Gustav Simon, of Heidelberg, in April, 1869. Blundell,¹ years ago, did nephrectomy on the rabbit, and proved that, in that animal at least, the kidney might be removed without causing death. Three different surgeons had preceded Simon in excising the human kidney, but without knowing the nature of the tumors they were removing until the operations had been completed. The first of these operations was performed in 1861, the others in 1867 and 1868. The ventral method was employed in each, and all the patients died. Simon's case was the fourth in which nephrectomy was performed, and the first in which the lumbar method was adopted. The patient fortunately recovered, and from that time the operation has been recognized as a legitimate one.

Lumbar nephrectomy should be performed in cases in which the removal of a disorganized kidney is advisable, after nephrotomy has been tried and failed to improve the condition of the patient; in cases of nephrolithiasis for which nephrolithotomy is not practicable; in cases of ureteral urinary fistulæ; in cases of wounded or ruptured kidney which are injured past the probability of functional repair, or in which blood-clots are being forced into the ureter, and plug it so as to lead to urinary extravasation into the loin, or to acute nephritis of the injured organ and threatened implication of the peritoneum. It should also be selected in dealing with renal cystic tumors, and small or medium-sized solid tumors of the kidney, and for some cases of painful, movable kidneys, which are condemned to removal. Other cases of large tumors, and of wandering kidneys very loosely held by a mesonephron, are better dealt with by the abdominal method. But here I would emphatically commend the teaching of Simon, who has laid it down as a cardinal principle that extirpation of a kidney is only permissible when a patient's life is seriously threatened by disease, and when all other remedies have failed, because renal disease is more dangerous in persons with only one kidney. The suffering caused by a floating kidney ought therefore to be quite irremediable by other means, before the patient is exposed to the great risks—operative and prospective—of nephrectomy; and in renal calculus no pains should be spared to procure relief by nephrolithotomy before proceeding to the much graver operation of excision. Rayer and Moseler have tabulated 14 fatal uni-renal cases; in 7 death was sudden, and due to obstructed ureter and anuria; and in 9 there was renal calculus.

It is probable that future experience will exclude from the category of cases for which nephrectomy by any method should be done, tubercular disease, and renal sarcoma in children, as well as cancer at any period of life. In cancerous tumors it is not likely that life can be much prolonged, unless in the exceptional cases in which the disease is detected before it has existed long, or has affected the lymphatic system. In tuberculosis, which, when it affects the genito-urinary tract, rarely confines itself to one organ, much temporary relief may be given by nephrotomy; but nephrectomy is only advisable, and safe from the special danger of anuria, in very exceptional instances. Here all will depend upon the character of the urine secreted by the other kidney—

¹ Remarks on Abdominal Surgery. (Ashwell, op. cit. 1828.)

a point most difficult to determine. The best guides are: (1) The normal character of the urine as to absolute quantity and percentage of the excreted solids, the excretion of urea being the chief test. (2) The absence of albumen, over and above what is explained by the existence of pus in the urine. (3) The urine having an acid reaction. (4) The absence of vomiting—vomiting, as pointed out by Dr. Barlow, being often a distressing symptom when both kidneys are diseased. Mr. Davy informs me that the last application of his rectal lever has been to effect the compression of one ureter so as to ascertain the condition of the excretion from the opposite kidney. Methods of catheterizing the ureter have been proposed, but are not, I think, of any practical utility.

In speaking of tuberculosis of the kidney, a distinction ought to be made between it and strumous pyelitis or pyonephrosis. In the latter, there is less tendency for the disease to spread along the ureter, and to affect more than one part of the genito-urinary organs; and the disease chiefly affects the calyces of the kidney, whereas tubercle commences in the cortex and passes downwards.

The advantages of the lumbar operation are twofold: (1) the peritoneum is not opened, and (2) the wound permits of excellent drainage. It is performed most easily by the transverse or slightly oblique incision, as in nephrotomy, made somewhat nearer the last rib than in lumbar colotomy; with this should be conjoined a second incision, running longitudinally downwards from the first, and starting from it about one inch in front of its posterior extremity. In making the first incision, which should be about $4\frac{1}{2}$ inches in length, the operator must not go nearer than half an inch of the twelfth rib, for fear of wounding the pleura, which sometimes descends a little below it. The second incision may be left until the kidney has been reached and explored, and it can then be made by cutting from within outwards with a probe-ended bistoury, steadied by the index finger of the left hand. One great advantage of the longitudinal incision is the increased facility which it affords for passing the ligatures around the pedicle. Other incisions have, however, been employed. Simon originally adopted the longitudinal; Klineberger made a curved incision, having its convexity upwards and outwards; and several surgeons have used the ordinary lumbar-colotomy incision alone. Lucas, in an excellent article on the surgical diseases of the kidney, recommends an oblique incision half an inch below and parallel with the last rib, and a second incision "along the outer edge of the quadratus lumborum, commencing at the upper edge of the last rib, and extending to the iliac crest;"¹ but the upper end of such an incision would be in dangerous proximity to the pleura, which would in some subjects be wounded by it.

The kidney being reached, the next step is to separate it from its surroundings. When no peri-renal inflammation has existed, the colon, peritoneum, and fatty tissue will easily be detached from their connection with the kidney, by the index finger of one hand worked close against the capsule of the organ. It will generally, however, I think, be found that, even when no inflammation has occurred, some of the renal capsule will be torn off and left behind; and in other cases, as when the operation is performed for calculous or scrofulous pyonephrosis, and as a subsequent proceeding to nephrotomy, the kidney should be enucleated from its thickened and adherent capsule, which should be left behind with the pedicle.

The next step is to pass a double ligature of plaited silk through the pedicle, between the ureter and the vessels. This is done by means of an aneurism-needle fixed in a long handle, whilst the kidney is dragged well up into

¹ British Med. Journal, Sept. 29, 1883, p. 615.

the wound by the operator's left hand, one of the fingers of which can at the same time be acting as a guide for the needle. The needle passed and withdrawn, the ligature silk should be divided, and one-half of it should be tied tightly around the vessels, and the other half around the ureter. In doing this, the ligatures should be pressed well inwards towards the front of the spine, so as to leave plenty of room between them and the hilus for dividing the pedicle. The kidney should now be drawn quite out of the wound, a proceeding which is sometimes very difficult, but which will be greatly facilitated by dragging the lower ribs forcibly upwards with the fingers of the left hand dipped into the wound. Another ligature should be thrown round the whole of the pedicle, and securely and tightly tied before cutting the kidney free, which is now safely done by snipping through the ureter and vessels with a pair of blunt-ended scissors. Any bleeding points should at once be seized, and ligatured or twisted, and it is very probable that when the wound comes to be fairly looked into, as it can after the kidney is cut away, some moderate-sized vessel will be found bleeding. Some aberrant branch of the renal; or one of the inferior supra-renal arteries; or the branch to the upper end of the ureter, or to the connective tissue of the loin—all branches from the renal trunk; or one of the parietal branches of the aorta, may require control.

All the ligatures should be cut off short, and the pedicle dropped into the wound. A drainage-tube should be fixed in the wound, the edges brought together with waxed-silk or fishing-gut sutures, and whatever form of dressing is commonly employed for fresh wounds by the operator, should be applied. The patient should be kept in the recumbent position until healing is complete, and the drainage should be kept up for four or five days. Healing is, as a rule, rapid, though the drainage-track will require from three to four weeks to close perfectly, and it is well that during all this time complete quietude should be observed, and great care given to the diet, so that the other kidney may not be irritated by too great concentration of the urine.

Some surgeons attach importance to the separate ligature of the artery, vein, and ureter; others, again, think it is unnecessary to ligature the ureter; and others, that the ureter had best be stitched to the external wound. The most important thing, however, is to securely control the vessels without putting too great a strain upon them in doing so. To attempt, in all cases, to get the kidney to the surface before ligaturing the vessels, would be to run a great risk of lacerating the coats of the artery or vein beyond the point at which it is possible to apply a ligature, and the advantage of leaving the ureter untied has yet to be proved. In no case is it advisable to excise the last rib; and where the costo-iliac space is very narrow, some other form of operation—not the lumbar—should be adopted.

The dangers of the lumbar operation are, that (1) the peritoneum or the colon may be torn open; (2) too great strain on the vessels of the pedicle may cause their laceration, or the ligatures may slip after the kidney has been cut off; (3) the kidney may be broken in the manipulations required for its separation and withdrawal. All these accidents have occurred, but they are not necessarily fatal. Laceration of the kidney requires the control of hemorrhage by pressure, and by hastening the completion of the removal: a great safeguard against hemorrhage from laceration is the application of the double ligature before attempting to withdraw the kidney. If the ligatures have slipped, or fail to control the vessels of the pedicle, or if troublesome hemorrhage from any source arises, it can be best managed by the application of one of Wells's large ovariotomy forceps, which should be left in the wound, and will, in addition, act very well instead of a drainage-tube. If the colon be torn, the rent should be closed by suture; if the peritoneum is

opened, it may be either sutured or left without stitches, as the surfaces will fall together and quickly adhere. In Mr. Couper's case of serofulous pyelitis, the hole in the peritoneum was sutured, but before this was done, pus from the kidney had contaminated the inner surface of the peritoneum; yet the patient rapidly recovered, and the operation, which lasted two and a half hours, was throughout all but bloodless.

Abdominal nephrectomy should be performed in cases unsuited to the lumbar method. These have been already specified. The best incision is that which many of the old surgeons employed in all abdominal sections, and which Langenbuch, of Berlin, has recommended and practised in at least two successful cases of nephrectomy,¹ namely, along the outer border of the rectus abdominis muscle on the side of the kidney to be removed. The middle point of the incision will probably correspond to the umbilicus, but this must entirely depend upon the size and outline of the tumor.

All bleeding, which is sometimes considerable in this incision, being stopped, and the peritoneal cavity opened, the state of the opposite kidney can be ascertained, if need be, by digital examination. The intestines should be kept aside, from off the surface of the kidney to be removed; by means of a large, flat sponge introduced into the abdomen. The outer layer of the meso-colon should next be opened sufficiently to allow of the introduction of two or three fingers, behind the peritoneum, and into the fat in front of the kidney; and the fingers should then gently tease their way towards the renal vessels, around which ligatures should be secured. If the vessels are tied separately, care should be taken to tie the artery before the vein. The ureter should then be seized by two pairs of ovariotomy forceps, and divided between them. Langenbuch's object in selecting this incision was to divide the outer layer of the meso-colon, and so avoid the risk of hemorrhage; this is more particularly necessary on the right side, since the inner layer of the meso-colon covers the vessels passing to the ascending colon. The enucleation of the tumor should next be proceeded with; and lastly, the vessels should be divided outside the ligatures, and the mass removed from the body. The ureter should be tied with ligature silk like the vessels; or its upper end may be turned out (as I suggested at a meeting of the London Medical Society, in November, 1882) through an opening specially made in the loin, and then stitched to the external wound. Mr. Barwell has also advocated this mode of treating the ureter; but I am not aware that it has been carried into practice. The supposed advantage of bringing out the end of the ureter, is that it allows the escape of any pus or serofulous material which it may contain, and that it permits the antiseptic irrigation of the canal. The advantage of this is doubtful, except, perhaps, in serofulous pyonephrosis, whilst the plan of fixing the cut end of the ureter at the abdominal wound, seems to me to invite the future occurrence of intestinal obstruction.

Abdominal nephrectomy is completed like ovariotomy, and the subsequent treatment is the same. A median incision has been several times employed, but is not as good as that described above. The dangers of the operation will appear from the following comparison of the causes of death after the lumbar and abdominal methods.

From an examination of 42 fatal cases, out of 100 nephrectomies collected by Dr. Robert P. Harris,² I find that the following facts come out. The cases are arranged according to the nature of the operation:—

¹ Transactions of the International Medical Congress. 1881.

² Amer. Jour. Med. Sciences, July, 1882.

Causes of Death.	Abdominal Nephrectomy.	Lumbar Nephrectomy.
Suppuration	1	0
Peritonitis	10 (4 being septic)	2
Hemorrhage	4	1
Uræmia	1	5
Shock	4	7
Infarction	2	0
Pyæmia	1	2
Vomiting	0	2
Total	23	19

As the whole number of abdominal operations was 46, and that of lumbar operations 50—the nature of the operation in 4 cases being uncertain—it appears that peritonitis, hemorrhage, pulmonary embolism, pyæmia, and exhaustion from suppuration, are more frequent causes of death after abdominal nephrectomy than after lumbar, in the proportion of nearly four to one; whilst the number of deaths from “uræmia,” “vomiting,” and “shock,” after lumbar nephrectomy as compared with abdominal, is fourteen to five. The greater mortality of the lumbar operation from uræmia and shock, is due to the fact that in several of the lumbar cases both kidneys were diseased at the time of the operation, that in one case the last rib had been removed and the pleural cavity laid open, that in another the patient was reduced by cancer of the uterus, and that others of the patients were in an unfit state for any surgical operation of importance.

The abdominal operation, therefore, seems to be a much more formidable affair for the patient; and the fatality from causes directly traceable to the operation, and apart from the state of health of the patient, much higher. Looked at from the point of view of the totals, the same conclusion is arrived at, but the difference is not as striking. Thus, out of 100 cases, the nature and result of the operation were recorded in 96. Of the 96 patients, 46 submitted to abdominal nephrectomy, and, of these, 23 recovered and 23 died; 50 were operated on by lumbar nephrectomy, and of these, 27 recovered and 19 died. A good deal as to result depends upon the nature of the disease for which the operation is performed, but less than might *a priori* be expected. Of 18 operations for malignant disease, 9 were fatal; and of 16 for floating kidney, 6 were fatal. Of the 16 patients with floating kidney, 14 were submitted to abdominal operation, and 6 died; two were treated by the lumbar method and both recovered. Of 7 lumbar operations for ureteral fistula, 6 ended in recovery and 1 in death.

I think that the conclusion pointed out by these figures, is that, though in many cases, from the size of the tumors, the abdominal operation is easier, and therefore better, yet that the lumbar method is as a rule much safer, and should be preferred in all cases in which the kidney is not much enlarged, in which the tumor can be reduced by puncture, and in which the loin space is not too much contracted.

Kroner¹ has collected and analyzed 41 cases of nephrectomy. In 21 the abdominal operation was performed, with 14 deaths; and in 20 the lumbar operation, with 5 deaths, but in 3 others the result is unstated. From these cases Kroner concludes that the higher mortality of the abdominal operation is not owing to its greater danger, but that it is due to the fact that these cases include those in which the diagnosis was uncertain, and in which the operation was therefore commenced tentatively.² [The whole number of cases

¹ Archiv für Gynäkologie.

² Kroner's cases are included in Harris's list, but for a good abstract of Kroner's conclusions, the reader may refer to the Medical Times and Gazette for October 22, 1881.

of nephrectomy hitherto recorded is over 250, of which over 100 have terminated fatally—a percentage of mortality corresponding pretty closely with that derived from Kroner's and Harris's statistics.]

Lateral Retro-peritoneal Nephrectomy.—Mr. Thornton has suggested a method which may be described as the lateral, retro-peritoneal operation. It consists in making an incision parallel with the linea semi-lunaris, but further out, and then reaching the kidney by raising the colon and peritoneum. The plan would probably answer very well for certain cases of tumor, and Mr. Thornton has employed it successfully in a case in which the ureter of a healthy kidney had been divided in ovariectomy. The advantage claimed for abdominal nephrectomy and for the lateral, retro-peritoneal method, is that they enable the vessels to be isolated and tied before the main enucleation is performed, and that thereby hemorrhage is saved.

The curved incision used for ligaturing the common iliac, or aorta, might be substituted for the lateral method of Thornton.

SPLENOTOMY AND SPLENECTOMY.

(Excision and Extirpation of the Spleen.)

In 1678, Matthias¹ removed the protruding spleen from a man aged 23, who had been stabbed. The patient recovered in three weeks. In 1711,² a woman aged 30 had an abdominal abscess opened to the left of the umbilicus, and a bluish body, which was seen at the opening, was removed; it proved to be the spleen. The patient made a good recovery, and afterwards bore a healthy child. Blundell,³ in 1823, experimented upon rabbits, and in seven instances took out the spleen. Two recovered permanently, and were fat and well five years afterwards. Two recovered temporarily, but died three and a half and six months afterwards of peritonitis, and in each, a large sac about the size of an orange, and filled with a thin, puriform fluid, was found in the left hypochondrium. Three died from three to five days after the operation from peritonitis. Blundell also refers to two successful cases of excision of the spleen, in which the spleen protruded through a wound in the side. These cases have been referred to in speaking of wounds and protrusion of the spleen. (1. A case of sabre-wound received at the battle of Dettingen, and 2. A Mexican under the care of Dr. O'Brien.)

A surgeon named John Ferguson, of Strabane, writing in 1734⁴ to Mr. Cheselden, Surgeon to Chelsea Hospital, describes a case of penetrating wound, with protrusion of the spleen, three and a half ounces of which he ligatured and cut away after the wounded man had had his spleen protruding twenty-four hours; the patient recovered from the operation. In reference to this case, Ferguson, in his note to Cheselden, says, "for though you have taken the spleen out of a dog without any remarkable inconvenience, yet it has never been attempted that I know of in a human body." Other cases have been recorded,⁵ which prove that complete recovery has taken place after total, as well as after partial removal of the spleen for injury with protrusion. Dr. Wilks⁶ was the first in England, who by his writings advocated the trial of splenectomy for disease.

¹ Quoted by Simon, of Rostock (*Die Extirpation der Milz am Menschen*. Giessen, 1857).

² Fantoni, *Opuscula Medica*. Geneva, 1738; quoted by Simon.

³ Ashwell, *op. cit.*

⁴ *Philosophical Transactions* for October and November, 1738, p. 425.

⁵ Cases are given by Hecker, Simon, and others.

⁶ *Guy's Hospital Reports*, 3d series, vol. ii. p. 37.

Causes for which the Spleen has been Excised.—From a table published by Mr. Herbert Collier,¹ it is seen that out of twenty-nine operations performed for diseased conditions since the year 1549, thirteen have been for diseases other than leucocythemia, and sixteen for leucocythemia of the gland. Of these sixteen, all have been fatal. Of the diseases of the spleen unassociated with leucocythemia, in which splenectomy has been performed, in two cases it has been floating or wandering spleen; in one, hypertrophy associated with a floating state of the organ; in three, hypertrophy from malaria; in three, simple hypertrophy; in one, hydatid followed by a sanious discharge; in one, secondary enlargement after cirrhosis, and associated with ascites and anasarca; in one, sequestered spleen in peritoneal abscess; and in one, hypertrophy with a unilocular cyst containing three litres of viscid fluid. Of these thirteen cases, eight have recovered. [Of 43 cases of splenectomy for disease, to which the editor has references, 31 are known to have terminated fatally—a proportion almost identical with that shown by Mr. Collier's figures.]

For injury of the abdomen, implicating the spleen, and in several instances attended with protrusion, the results of excision and extirpation have been very encouraging. Nussbaum states that sixteen out of twenty-six operations performed for traumatic causes have been quite successful. [The editor has references to 21 cases of splenectomy for traumatic causes, all of which are said to have terminated successfully.]

Mode of performing the Operation.—The section of the abdominal wall has been variously made. In the first known case (Zaccarelli's, in 1549), the external incision was over the tumor. In Kuchler's (1855) and Spencer Wells's (1865) cases, it was along the outer edge of the left rectus. In Bryant's first case (1866), a longitudinal incision was made from the eighth rib to the anterior superior spine of the ilium on the left side; in his second case (1867), the incision in the left loin commenced "below the ribs, at a point corresponding to a line extending upwards from the anterior superior spine of the ilium, and curving downwards and forwards in front of the crest. This line of incision was selected as it was supposed to correspond with the horizontal line of the spine, and would thus, on the removal of the spleen, enable the surgeon to have the pedicle of the gland more immediately under his observation and control, and tend to prevent the risk of its being stretched or perhaps lacerated; it would at the same time allow of the removal of the very large organ in the readiest manner."²

In the majority of the operations performed for disease, the external incision has been along the linea alba. In operations for injury, the original wound has sometimes been enlarged, but in other cases even this has been unnecessary. The length of the incision varies with the size of the organ to be removed, from three inches or less, to ten inches or more. The best incision is that along the linea semilunaris, or that, still further out, employed by Mr. Bryant. All hemorrhage from the parietes having been stopped, and the peritoneum opened, the omentum will probably be found lying over part of the spleen. This must be pushed on one side, and then the hand of the operator should be passed over, above, and on each side of the spleen, to ascertain if any adhesions exist between it and surrounding parts. If any such are found, they must be broken through, with the same care to prevent hemorrhage as in ovariectomy, clamping and ligaturing as their separation is proceeded with. The spleen is next to be raised out of the abdominal cavity, lifting one end, generally the lower, out first. In doing this, precaution should be taken

¹ Lancet, Feb. 11, 1882.

² Guy's Hospital Reports, 3d series, vol. xiii. p. 414.

against lacerating the spleen-capsule and parenchyma; the latter is often very soft, and always readily bleeds. The spleen having been withdrawn, a clamp should be fixed upon the pedicle and the mass cut away. The pedicle can now be examined without difficulty, and should be ligatured in two or more parts, with strong, twisted silk or whip-cord; the clamp should be removed, and the ligatures should be cut short and dropped back into the abdomen. All blood should now be removed from the abdominal cavity by means of sponges, which should have been rendered thoroughly antiseptic. Throughout the proceedings, a good assistant must take care that the intestines be not allowed to protrude at the wound. Finally, the external wound is to be closed with interrupted sutures, as after ovariectomy; and the wound should be dressed with some light, antiseptic material, such as boracic-acid charpie, salicylic silk, or absorbent cotton-wool. The abdomen should be supported by a flannel roller. Adelmann proposes to divide the operation into two parts; first, the removal of the spleen from the abdomen through the smallest possible incision; second, after adhesions have formed, and the opening has been thereby closed, to separate the organ from the body.

After the operation, the patient must be kept lying upon his back, with the knees slightly raised by a pillow, and the urine must be drawn off every five or six hours. The dieting should be the same as after every other large abdominal operation.

Dangers of the Operation.—Hemorrhage may occur from a large vessel in the omentum, at a spot where it is adherent to the parietes at the seat of incision; from the rupture of some large vessel, such as the splenic vein; from the torn surface of the spleen itself; or, again, from the general surface of detached adhesions. In Mr. Bryant's second case, hemorrhage from the rotten, sponge-like adhesions which had connected the spleen with the lower surface of the diaphragm, caused death in fifteen minutes. In Sir Spencer Wells's case, a large artery was cut across in a piece of loosely adherent omentum, and afterwards the splenic vein gave way as the operator was twisting the spleen around to bring the vessels into a sort of cord before applying a ligature—a proceeding which this surgeon himself condemns.¹

In more than one case, a part of the pancreas has been included in the clamp or ligatures applied to the splenic pedicle; this should be guarded against.

Severe disturbance of the sympathetic nervous system has been witnessed in some cases; and severe and persistent vomiting has followed the operation. Attacks of faintness from anæmia have also been observed. As the length of time required for splenectomy is not great—often, indeed, less than half an hour—there is not the risk to life which is undergone, in some other operations, from prolonged influence of anæsthesia, or from prolonged exposure of the peritoneal cavity.

The most frequent cause of death has been hemorrhage, in some period varying from a few minutes to sixteen or eighteen hours. Shock has caused death in other cases during the operation, or within less than twenty hours afterward; and peritonitis has killed a few others in from three to six days.

The cases most suitable for splenectomy or splenotomy are those in which the spleen is involved in an injury, and the gland is, it may be, protruding through the abdominal wound.

When splenectomy is performed for disease, floating spleen, simple hypertrophy, and enlargement from malaria, give the best results. M. Péan successfully removed a hypertrophied gland containing a large cyst; his second case, also successful, was for simple hypertrophy. Martin's (Berlin) and

¹ Med. Times and Gazette, January 6, 1866, p. 4.

Czerny's successful operations were performed for floating spleen. The question of excision of the spleen for cancer is not likely to arise. It is doubtful if this organ is ever the seat of primary carcinoma, and it is impossible that it should be, if the theory of the epithelial origin of cancer is correct. Quite recently, however, a German has recorded three cases of "primary epithelioma of the spleen," but it is the opinion of others that these cases in no way differ from some forms of lymphadenosis.¹

For leucoeythæmia, whether in the early or late stages, splenectomy should not be performed: first, because the enlargement of the spleen is only a part of a general disease; and, secondly, because there is such a great tendency to hemorrhage that even slight operations upon leucoeythæmic subjects should, as far as possible, be avoided.² Credé, of Dresden, not only condemns the operation for leukæmia, but thinks the only diseased condition in which it is justifiable, is cystic degeneration of the spleen. He reports a case in which he performed it successfully for this cause in a young man aged twenty-four. In this case, Credé observed that the white blood-cells were increased at the expense of the red, eight days after the operations; that this increase continued for one month, and then was stationary for two months, and that in the fourth month the proportion fell to normal. During convalescence, Credé was unable to detect any enlargement of the lymphatic glands, or any disturbance in the marrow of the bones; but he noticed an inflammatory swelling of the thyroid gland during the fourth month. Credé believes, therefore, that the extirpation of the spleen produces a marked, temporary anæmia, as after severe hemorrhage, and that for a while the thyroid assumes the functions of the spleen, until the system becomes adjusted to its new relations.³

That movable spleen is a dangerous condition, and one for which splenectomy is, in severe cases, well suited, may be inferred from Rokitsansky's⁴ account of it. He gives three cases in which the spleen was found dislocated after death:—

CASE I.—The spleen was in the right iliac region, the pedicle was twisted, and the hilus was turned upwards and outwards; the patient was a woman, aged twenty-eight, upon whom Cæsarean section had been performed. The pedicle consisted of the pancreas, and the splenic vessels, the former making three spiral coils round the splenic artery. The pancreas was about ten inches long, being drawn out and considerably attenuated.

CASE II.—The spleen was in the left iliac region, being attached by a long pedicle to the omentum. It occurred in a microcephalic woman, aged forty-six, who died of tubercular ulceration of the liver and lungs.

CASE III.—The patient was an insane woman, aged sixty-nine; the spleen lay to the left of the upper aperture of the pelvis, attached by false membrane to the sigmoid flexure and coils of small intestine. The splenic artery was elongated and twisted, and its branches were blocked here and there. The vein was blocked. The spleen was the size of a goose's egg, and its capsule was thickened.

Dislocation of the spleen generally occurs in the female, and generally in the direction of the left iliac fossa, and it generally results from tumefaction of the spleen and want of tone in the ligaments. The pedicle becomes twisted during

¹ *Lancet*, April 14, 1883.

² For a concise summary of opinions on the subject, see Mr. Collier's paper (*loc. cit.*, February 11, 1882, p. 222).

³ *American Journ. Med. Sciences*, October, 1882, p. 606; *Deutsche med. Wochenschr.*, 10 Juni, 1882.

⁴ *Zeitschrift der k. k. Gesellsch. der Aerzte zu Wien*, No. 3. 1860; *Brit. and Foreign Med.-Chir. Review*.

the descent of the organ, and the vessels of the pedicle are narrowed or obliterated. The spleen forms adhesions in its new site, and owing to the interference with the circulation in the splenic vessels, the gland atrophies and degenerates. Death may occur from continued traction upon the fundus of the stomach, or from gangrene of the spleen.

As splenectomy is unjustifiable in leukæmia, and yet as the blood of the splenic veins contains a larger proportion of white corpuscles than the rest of the blood, it has been proposed to cut off this excess of white corpuscles by bringing about an atrophic change in the spleen by some other operative measure. Thus it has been suggested that a ligature should be placed upon the splenic artery; but apart from the difficulty of tying the vessel, with the abdomen largely filled with an enlarged spleen, there is the fear that the spleen would necrose and cause death, as in some cases of twisted pedicle with splenic dislocation. Electricity has been locally applied to the spleen, but though the patients so treated have expressed themselves as relieved by the application, and have begged for its continuance, no permanent therapeutical effects have been produced. A diminution in the size of the spleen has been frequently noticed after the application, and in fourteen out of eighteen observations recorded by Dr. Vivian Poore, the number of white corpuscles was increased after the use of electricity. As Dr. Poore therefore remarks, it seems probable that the contraction of the spleen results in a forcing of the leucocytes into the general blood-current, and as the red corpuscles are diminished, it goes to show that the function of the spleen is destructive of red corpuscles.¹

Another mode of operating upon the spleen in leucocythæmia and hypertrophy, is the injection of drugs into its substance. Hammond obtained rapid reduction in bulk by injecting ergot.

A parenchymatous injection of one gramme of sclerotic acid was followed by death in six hours, and at the post-mortem examination no infarct and only a little reddish zone at one of the punctures was found. The spleen was leucocythæmic.

Mosler, of Greifswald, prefers Fowler's solution to ergot, and has used it successfully in four cases; he applies ice to the spleen before injecting.

Kussmaul, of Strasbourg, tried a repetition of simple punctures with a large needle, hoping thus to produce hemorrhagic infarcts, and a considerable shrinking and reduction in size as the consequence; but the result was disappointing. Galvano-puncture has not been more successful.

Dr. Emanuel, of St. Louis, reports a good result from the internal use of ergot; thirty drops of the extract were given three times a day, and the dose was gradually increased to sixty drops. The patient, a gentleman aged forty-three, had a greatly enlarged spleen, which in a fortnight nearly filled the abdomen; but about ten days after the treatment by ergot was commenced, it resumed its natural size.²

PYLORECTOMY OR PARTIAL GASTRECTOMY.

This operation was first performed by Péan,³ of Paris, in 1879, but his patient died on the fifth day; the first successful results were obtained by Billroth and Wölfler. The attention of surgeons has since been drawn to

¹ *Lancet*, June 23, 1883, p. 1081.

² *Ibid.*, September 30, 1882.

³ *Gazette des Hôpitaux*, No. 60. 1879.

the subject by the writings of Anton Wölfler,¹ Mickulicz,² Trognart,³ Rydygier, Gussenbauer, Winiwarter, V. Wehr, Manoury,⁴ Czerny, Sydney Jones,⁵ Southam, of Manchester, and others.

Though it has now been performed thirty times or more, the operation still has about it so much of the nature of an experiment—perhaps even of a mere surgical exercise, if one may be allowed the expression—that it is not possible to describe it at present as a thoroughly recognized surgical proceeding. As yet, the surgical mind is not settled either as to the conditions for which the operation should be performed, or as to the precise steps of the operation; or indeed as to the justifiability not to say advisability of its performance.

The Diseases for which Pylorectomy has been proposed.—As yet it has been performed almost exclusively for cancer of the pylorus, but with most disastrous consequences. Twice at least, and successfully, it has been done for simple chronic gastric ulcer; and once, also successfully, for stricture of the pylorus following perforating ulcer. (Heuck, of Heidelberg.) It has been proposed to excise the cicatrix which results from the action of corrosive acids, if the contraction should give rise to pyloric obstruction; and it has further been suggested that in perforation of the stomach with extravasation, laparotomy followed by excision of the diseased structures and cleansing of the peritoneal cavity should be performed. Czerny⁶ maintains that “excision of the pylorus ought not merely to be confined to cases of cancer of the stomach, but that a great future is opened up by it for those cases of simple stricture of the pylorus in which an incurable dilatation of the stomach is found. And this is an argument already put forward by Gussenbauer and Winiwarter.”

The Operation.—Before the operation is decided upon, the surgeon ought to have satisfied himself as to the nature of the disease, and the justifiability of operating under the conditions of the case in question. The symptoms should point unmistakably to pyloric obstruction. If the disease is not malignant, there should be good grounds for believing that it will, if left alone, assume a perilous character; that the lumen of the strictured part will become less and less, and the gastric dilatation more extreme; and that ulceration, and possibly perforation, will ensue. If the disease is malignant, the tumor should be felt to be freely movable; jaundice, ascites, anasarca of the lower limbs, and every other indication of secondary disease should be absent; and further, the patient's health should not have been so far deteriorated as to render success impossible. In some instances, in which the conditions have been apparently very favorable, they have not turned out to be so when the abdomen has been laid open. The mobility of a cancerous growth of the pylorus, when examined through the parietes with the patient under chloroform, is no proof that the tumor is free from important adhesions. In a case under the care of Professor Lichtheim,⁷ the growth was easily moved in different directions, yet on opening the belly it was found to be so firmly adherent that it could not be excised, and the operation was abandoned. The chain of lymphatic glands behind the stomach, at the head of the pancreas, in the omenta and mesentery, may be extensively implicated without giving palpable evidence of disease. The rapidity, too, with which the glands in the neighborhood of the hepatic fissure may be involved, must make the prospect of even a successful operation very doubtful.

¹ Resectionen des carcinomatösen Pylorus. Wien, 1881.

² Journal de Médecine de Paris, 5 Août, 1882.

³ Journal de Médecine de Bourdeaux, 1883.

⁴ Le Progrès Médical, 26 Nov. 1881.

⁵ Lancet, Nov. 25, 1882, p. 889.

⁶ Transactions of the International Medical Congress, vol. ii. p. 233. 1881.

⁷ Brit. Med. Journal, June 3, 1882.

A man under my care in the Middlesex Hospital, with a movable cancerous mass in the pyloric region, consented to the operation of pylorectomy; his strength and general as well as local condition seemed favorable, and all the final preparations for the operation had been made, when some increased distinctness of the superficial veins of the abdomen, and some slight tumidity in the lumbar regions of the abdominal cavity, as he lay on his back, suggested the advisability of watching and waiting for a day or two. Within a week the whole abdomen was distended with ascitic fluid, the surface veins were greatly enlarged, and the lower limbs œdematous. The patient lingered on several weeks, and died with abundant secondary cancer. It is needless to speculate upon what might have been the result of the operation had it been attempted in this case.

When it has been decided that the case is one fitted for interference, the patient is to be prepared by having the stomach well washed out, and, if the stomach has become much dilated, the washing out ought also to be repeated on the day preceding the operation. The abdominal parietes should be divided, and the peritoneal cavity opened, by an incision four or five inches in length. This may be made in one of three ways: (1) Parallel to the right costal margin (Wölfler); (2) transversely over the most prominent part of the tumor (Billroth and Wölfler), though if this have sunk down very low in the abdomen—as when the pylorus is non-adherent and weighty it will do, even reaching the level of the symphysis pubis—the tumor must be raised before the incision is made over it; (3) longitudinally, in the *linea alba* (Péan), or a little to the right of it (Rydygier). Sometimes the transverse and longitudinal incisions have been combined before the growth has become accessible, as in Dr. C. Max Richter's case,¹ in which nearly the whole of the lesser curvature was infiltrated; the transverse incision was five inches long, and about one inch above the umbilicus, while the longitudinal incision was made upwards from the transverse, along the median line to the xiphoid cartilage.

Before the peritoneum is incised, all bleeding points should be secured by torsion or ligature. In the transverse and oblique incisions the hemorrhage from the parietes may be somewhat excessive, and eight or twelve vessels may require to be controlled. Billroth, however, says that Mickulicz considers the transverse incision the best, as it gives more room than an incision along the *linea alba*, and heals equally as well. The relation of the disease to the surrounding parts is to be made out as soon as the peritoneum is opened, and this is to be done either by introducing the fingers and feeling round the mass, or by withdrawing the mass, when possible, through the external wound. If the growth has invaded, or is adherent to, the pancreas, liver, or transverse colon; if the lymphatic glands in the neighborhood are widely involved; or if the cancer extends to the second portion of the duodenum, or over the whole or greater part of one of the curvatures of the stomach, the operation should be abandoned, and the parietal wound should be closed. If the abdominal walls are invaded by the disease, the operation may be completed, though with difficulty.

If the operation is proceeded with, the next step is to detach the stomach from the greater and lesser omenta, and for this purpose the stomach is drawn up into the wound, and its walls carefully examined to ascertain at what point they should be cut through. The division of the omenta should then be made step by step, between two pairs of pressure-forceps, ligaturing the cut ends before removing the forceps; or double ligatures may be passed with an aneurism-needle at short intervals through the portions of the omenta to be divided, and the section made after the ligatures are tightened. Sometimes the thermo-cautery has been employed to divide these structures, but there is no advantage in its use. If any glands are infiltrated, they should be

¹ Am. Jour. Med. Sciences, 1882.

removed at this stage. As soon as the diseased parts have been isolated, a large and properly anti-septicized flat sponge should be placed beneath them, so as to protect the peritoneal cavity, and form a bed upon which these parts may lie whilst they are being cut away. The walls of the stomach are now to be cut through with seissors, commencing at the lesser curvature and making the division obliquely across its surfaces. All bleeding is to be arrested after each stroke of the seissors, and for this purpose many ligatures have been found requisite for the cut edges of duodenum and stomach.

If the stomach is not quite empty, its contents should be soaked up with a sponge specially reserved for the purpose. Mickuliez,¹ following Billroth, says that it is not necessary, after section of the stomach, to close it with Wehr's compressor, because, if care has been taken to wash out the stomach well before the operation, no escape of contents need be feared. Rydygier places his compressors on the stomach and duodenum, and then removes the tumor by dividing the intestinal walls near to the compressors. The pylorus, now held by volsella-forceps, is next to be separated from the duodenum, which should be snipped through stage by stage, in the same careful and gradual manner as the stomach, arresting the bleeding as it occurs. Lest the gut should slip back into the abdomen, a loop of silk should be passed through its serous and muscular coats, below the point of section, and it should be thus gently held by an assistant. A plug of carbolized cotton-wool, or a small sponge, may be temporarily inserted into the open orifice of the duodenum.

With the view of diminishing as far as possible the inequality in the size of the openings in the stomach and duodenum, Wehr advises the enlargement of the duodenal orifice by making an oblique instead of a transverse incision across it. Rydygier, on the other hand, diminishes the size of the gastric orifice by cutting out a triangular piece in the greater curvature, and sewing together the edges of the notch thus made. Billroth closes the gastric opening until it is of the same size as the duodenal. In a case of successful pylor-ectomy for gastric ulcer, reported by Dr. Van Kleeft,² of Maastricht, the opening into the stomach was so small that only one finger could be inserted, and it had to be actually enlarged to make it fit the duodenal opening. This is a condition worth remembering when operating for simple ulcer or cicatrix.

The diseased mass having been excised—or, it may be, even before its separation from the stomach is completed—the cut edges of the stomach in part of the length of the wound should be brought together by sutures, care being taken that the serous coats are applied to one another. In attaching the duodenum to the rest of the edges of the wound in the stomach, it is best to begin at their posterior walls. After permanently adjusting the posterior portions, the anterior parts of the stomach and duodenum are to be united. Throughout, the serous surface of the stomach must be retained against the serous coat of the duodenum. Billroth recommends inserting the posterior sutures from the inner surface before the duodenum is completely divided; or several threads may be carried through the walls of the stomach and duodenum to form the posterior "ring suture," and should be held by an assistant whilst the separation of the growth is completed and the occlusion-sutures are adjusted. Either Lembert's or the continuous suture, interrupted and finished off after every four or five stitches, as suggested by Pollock,³ should be employed. Wehr and Billroth attach great importance to the manner of placing the sutures; and Billroth, before closing the abdomen, examines each suture to see that it is fast. Fine silk, such as the Chinese twist, is a good

¹ Journal de Méd de Paris, 5 Août, 1882.

² American Journ. Med. Sciences, April, 1883, p. 582.

³ Holmes's System of Surgery, 3d ed. vol. ii. p. 742.

material for the sutures. Billroth and Czerny used carbolized silk; Rydygier, catgut. The number of sutures required is generally very large, from forty to sixty having often been employed; when the opening in the stomach is very small, fewer sutures will of course suffice. In two cases (one of which was successful) Billroth stitched the duodenum to the lesser curvature, and closed the gastric orifice by transverse sutures. He thinks, however, that there is less traction on the stomach, and a more direct passage from the stomach to the duodenum, if the gut is fixed to the greater curvature. This plan he adopted in his third case. The wound in the parietes should be closed by interrupted sutures passed through all the layers of the walls, including the peritoneum. Boracic charpie, salicylic wool, or absorbent cotton-wool, should be bandaged over the front of the abdomen, and the patient placed in bed upon the back, with the knees raised.

After-treatment.—For the first twenty-four or thirty-six hours, or longer if possible, the strength of the patient should be sustained by nutritive enemata given every four or six hours. Each enema should consist of two ounces of strong beef-tea, half an egg, and a drachm of brandy, with a little opium if required. The mouth may be moistened from time to time with a teaspoonful of iced water or fresh milk. After the first twenty-four hours, the patient may commence to take fluid nourishment in small and frequently repeated doses, and by degrees a light solid diet may be permitted if all goes well. Van Kleef's patient ate beef-steak on the tenth day. Czerny's patient took meat on the fifth day, and was up on the twentieth.

Duration of Operation and Extent of Parts removed.—No one must undertake excision of the pylorus without being prepared for a long and tedious operation. The shortest time occupied has, I believe, been one and a half hours. Most cases have taken from two to three hours or more, and some have occupied at least five hours.

The extent of stomach removed varies of course with the extent of the disease; but it has amounted to five inches and more along the greater curvature, and three or four inches along the lesser. In one case, nearly the whole of the lesser curvature was implicated and removed; but the patient died in three hours. The weight of the mass removed in Lauenstein's case is stated as about nine and a half ounces. In Wölfler's¹ case, the tumor, when removed, was the size of an apple. The patient did well.

Dangers of the Operation.—The complicated anatomical relations of the pylorus, the size of the viscera divided, the unavoidable tediousness of the manipulations, and the consequent prolongation of the anæsthetic state, must always cause pylorotomy to be one of the most formidable and exhausting, as well as difficult operations. Shock and collapse have been the most frequent cause of death; and hemorrhage, more especially when secondary, is a source of great danger. Peritonitis has not been a frequent complication. In one case (Lauenstein's), a large portion of the transverse colon mortified; adhesions had existed between the posterior surface of the stomach and the transverse meso-colon, and had had to be ligatured and divided: and in this way, probably, by the cutting off of the arterial supply, gangrene of the bowel ensued and killed the patient about the eighth day. Probably the greatest difficulty in the operation is the separation of adhesions. In the small number of recorded operations, the character of the adhesions found has been widely different. Besides the pancreas and colon, the vena cava and vena portæ have been found adherent to the growth. In Billroth's third case, the pyloric cancer was attached to the pancreas, and about one hour was occupied in isolating it; the entire operation took two and a half hours. The patient

¹ Edinburgh Med. Jour., November, 1882.

died the same evening, and cancerous glands were found near the head of the pancreas, and in the lesser omentum. The frequency with which adhesions will be met with may be inferred from Gussenbauer and Winiwarter's statistics. These show that out of 542 cancers of the pylorus observed at the Pathological Institute of Vienna, 370 had adhesions.

The mortality of pylorotomy or partial gastrectomy has been very high. Out of 29 cases, the operation has been performed in 27 for tumor of a malignant nature, and has been fatal in 23 of these. In two cases (Heuck's, of Heidelberg, and Van Klee's, of Maastricht), the operation has been done for gastric ulcer of a non-malignant type; and in both instances with perfect success and permanent recovery.

Thus 6 out of 29 patients have recovered from the operation. Of the 4 with malignant disease, 2 (Wölfler's and Czerny's) were known to be alive and well, without any symptoms of recurrence, many months (6 and 10 respectively) after the operation; one (Billroth's first patient) died four months after the operation, with cancerous disease of the peritoneum and retro-peritoneal lymphatic glands. Of the 23 fatal cases, none lived longer than eight days, and in most death resulted from the operation within a very few hours. [Of 88 cases to which the editor has referenees, 30 are said to have ended in recovery.]

With these results before him, I must leave the reader to form his own opinion as to the justifiability of the operation for malignant disease. For my own part, given a suitable case in a patient not too far worn out by his malady, I should feel justified in offering him the chance of prolongation of life which the operation might afford, and in performing the operation, if desired, after fairly acquainting the patient or his friends of its risks; but with my present knowledge I should not feel justified in advising the operation. In simple stricture of the pylorus, if incurable dilatation, with obstruction, exists, the operation seems to me to be not only justifiable but advisable.

OTHER OPERATIONS ON THE STOMACH.

GASTRO-ENTEROSTOMY is an operation which has been proposed for those cases of cancer of the pylorus in which excision is not possible. It was performed for the first time by Dr. Anton Wölfler, in Vienna, and has since been repeated by Billroth. This mode of treatment appears to have been devised on the spur of the moment, after an exploratory incision had been made into the abdomen of a man who was suffering from cancer of the pylorus, and in whom the operation for removal of the tumor proved to be impossible.¹ It consisted in making an incision into the stomach near the middle of the great curvature, and a similar cut into a coil of small intestine—probably as near as possible to the commencement of the jejunum—and carefully sewing to one another the margins of the two openings thus formed. The object of the operation was thus twofold—in the first place to allow the materials swallowed to pass into the intestine; and in the second place, to prevent any obstruction to the escape of the biliary and pancreatic secretions. Strict antiseptic precautions “with the exception of the use of the spray” were observed during the operation, and not only did healing take place without any fever and by first intention, but the patient experienced very marked relief, and at the time of the report had survived the operation nearly four weeks. Not only had he survived, but a marked improvement had taken place in his symptoms; the vomiting had stopped, and he had been able to take increasing quantities, first of fluid, and afterwards of solid food. He

¹ Centralblatt für Chirurgie, 12 Nov. 1881.

had also had daily evacuations of the bowels, the stools being firm and brown.

Billroth's case was also one of cancer of the pylorus, too far advanced for removal. The operation was apparently carried out in the same way; it was easy of performance, and lasted only an hour. The patient, however, was seized with biliary vomiting, which continued till he died on the tenth day. An explanation of the vomiting was found after death: there was no peritonitis; but the result of drawing the intestine towards the stomach had been to form a spur which divided the opening between the two viscera into two unequal parts, the larger of which communicated with the proximal portion of the intestine. The result of this was that the bile and pancreatic secretion, instead of passing into the intestine, were poured into the stomach, and the consequence was that which has been described. The author points out the necessity of making sure, to begin with, which is the proximal, and which the distal portion of the coil of intestine selected, and then of taking care that a thoroughly free communication shall exist between the latter and the stomach, while the former shall be, in a way, valved by making the stomach-wall overlap it. He also suggests that this method of procedure may possibly prove of value in cases of malignant growth in connection with the intestine.¹

DIGITAL DILATATION OF THE PYLORUS.—Professor Loreta, of Bologna, has proposed and performed forcible dilatation of the pyloric orifice in [seven] cases of simple stricture. A longitudinal incision through the abdominal parietes on the right of the linea alba, enabled the surgeon to reach and draw forward the stomach, which was then incised near to the pylorus. Through the gastric wound, the right index finger was passed on through the pylorus, after forcibly dilating it. The wounds were then closed in the usual manner. Complete relief followed the operation in [six] cases, and the first patient is known to have been alive and in good health five months after the operation, but how long the improvement was maintained is not known. [Other cases have been recorded by Hahn, McBurney, Schede, Giommi, Frattini, and Haggard.] It is a measure which, for simple strictures, seems to offer a fair prospect of success.

The following is the report of Prof. Loreta's first case, as given in the *Lancet* of August 18, 1883, p. 289.

Nicola C., aged 47, had suffered for the greater part of twenty years from imperfect digestion, distension of the stomach, sense of weight, and occasional vomiting. In 1878 he had been admitted into the Bologna Medical Clinique, and treated for ulcer of the stomach. Relief had ensued, but only for a short time. Eructation, a burning feeling in the throat, vomiting of undigested food, sometimes mixed with blood, increasing emaciation, and pallor of the skin and mucous membranes were noted. The man subsisted on a little milk. The distended stomach gave a clear note on percussion, from the fifth rib to the umbilicus. Microscopic examination of the fluid drawn by pump from the stomach yielded no evidence of organic lesion. On palpating the emptied stomach, a tumor could be felt in the pyloric region, with smooth and elastic surface, but not very well defined limits. As the patient was steadily sinking, Professor Loreta, on September 14, 1882, operated in the presence of numerous colleagues. Dr. Alfonso Poggi administered chloroform; the stomach was washed out with an alkaline solution; the incision into the abdominal wall was commenced a little to the right of the linea alba, and extended outwards and downwards for six inches; the lower angle was an inch and a quarter from the ninth right costal cartilage. In the incision were included the oblique and transverse muscles, and also a part of the rectus. On reaching the peritoneum the Professor stopped to tie some arteries and to await the complete arrest of bleeding from the edges of the

¹ The foregoing account of the operation is taken from the *Medical Times and Gazette*, December 3, 1881.

wound. The peritoneum was then opened. The omentum was extensively adherent by old inflammatory exudations. These were separated very slowly and carefully from the abdominal wall and from the surface of the stomach. This viscus was then drawn out through the wound, and the operator felt the pylorus much enlarged and of fibrous hardness.

In the space between the two curves of the stomach, and at a distance of an inch and a quarter from the pylorus, an opening was made into the viscus with a stout pair of scissors, through a transverse fold previously raised. The opening into the stomach was extended two inches and a half, and T-shaped forceps were used to arrest bleeding from the edges. The right index-finger was then passed into the stomach towards the pylorus, which was completely closed. The finger failed to pass into the duodenum in spite of considerable pressure and combined lateral and rotatory movements. The left index-finger was then introduced into the stomach, and used to fix the pylorus, while strong and renewed pressure was exerted to push the first phalanx of the right index into the narrow and contracted pylorus, which was then drawn forwards to the external wound. Along the right index-finger the left one was also introduced into the pylorus, but these attempts failed to pull one finger from the other, in spite of much force, sustained as long as possible ("moltissima forza, nel sostenerla quanto piu a lungo potessi"). After resting, the operator resumed his efforts and dilated the pylorus, though he only succeeded in doing so very slowly, and by employing very great force. The dilatation was continued to about three inches (eight centimetres). The stomach wound was then sutured with carbolized silk, the viscus replaced in the abdominal cavity, and the external wound closed with seven silver sutures. The patient was returned to bed thirty-three minutes after the commencement of the operation. On regaining consciousness the patient complained only of thirst, and of a slight burning sensation at the wound. Small pieces of ice were given from time to time. In the afternoon the patient complained of weakness and hunger, and relished the yolk of an egg beaten up with Marsala wine, given in teaspoonfuls every half hour. The temperature throughout the day was 98° F., pulse 72, respiration 26. The same kind of diet was continued. The third day after the operation the bowels acted after an enema; the fourth day, some broth and light paste were allowed; the fifth day, some chicken; the sixth day, bread was added to the diet: On that day the bowels acted spontaneously. The wound was first dressed on the eighth day, and five sutures removed. The incision had healed by the first intention. The two remaining sutures were removed on the eleventh day. The thirteenth day after the operation the patient's diet consisted of coffee and milk, bread, roast chicken, roast beef, eggs, and wine. He was out of bed for two hours and a half on the sixteenth day, and rapidly gained flesh and strength. Two days before the operation the man had weighed 122 pounds, and he gained about 33 pounds in six weeks. He continued to enjoy perfect health when presented to the Bolognese Academy, after the lapse of five months.

[DILATATION OF THE CARDIAC ORIFICE of the stomach has since been performed by Loreta and other surgeons, and with equal success.]

OPERATIONS ON THE PANCREAS AND LIVER.

Extirpation and excision of the *pancreas* and of the *liver* have not yet been brought within the category of surgical operations, except in cases such as have been referred to in other parts of this article, in which parts of the liver protruding through a wound of the abdominal walls have been ligatured and cut away, or more or less of the pancreas has been excised, with large pancreatic cysts or cancers of the pylorus.

Some experiments, made on animals, of removal of parts of the liver by means of elastic ligatures, have been recorded, but they give little if any promise of success. Indeed, for the most part, the experiments have resulted in complete failure.

[HEPATIC PHLEBOTOMY.—Under this name Dr. Harley recommends, in cases of acute hepatitis, the direct abstraction of blood from the liver, by means of an aspirating trocar and canula. He also advises, in cases of chronic congestion, puncture of the hepatic capsule. Both of these operations are said to have been frequently resorted to with success by Indian army surgeons.]

URINARY CALCULUS.

BY

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“To make calculi of uric acid without colloids would be as hopeless a task as making ropes of sea sand.” “The pebbles of the concrete would not hold together without the cement to bind them and act on their surface.”

The enunciation of this truth, by William M. Ord,¹ marks the starting point of a new era in the scientific study of calculous formation. The experiments leading to these conclusions, begun by Rainey and improved upon by Ord, are the first serious efforts toward a scientific appreciation of the subject of which we have any record.

The beautiful micrographic illustrations of large thin sections of urinary calculi, recently published by Ultzmann,² and the accompanying lucid descriptions, seem to establish beyond question that there is a law governing the massive crystallization of the various urinary salts, as uniform in its action as that which regulates the structure of the smallest crystal. Urinary calculus is not an accidental agglomeration of solids, crystalline and amorphous, in a cement of mucus. It is a massive crystallization of urinary ingredients in a colloid, and its formation occurs in obedience to a fixed law. Ultzmann recognizes that there is a law and demonstrates it; but he fails to grasp the idea of the colloids, or to mention their influence. He recognizes only two causes of the crystallization—1, an appropriate chemical condition of the urine; 2, an abnormal condition of the urinary apparatus—notably inability on the part of the bladder to empty itself entirely.

The first appearance of calculous disease cannot be determined, but in the nature of things it must have shown itself, or rather its symptoms must have appeared, soon after the earth was peopled, unless prostatic enlargement is a malady of modern times, which there is no reason to believe.³

Certain it is that an authentic record of stone exists in a medical treatise, called *Sucruta*, a Hindoo work, believed by some authorities to antedate the Hippocratic collection. In this work, which was published in Sanscrit, at Calcutta, in 1835, and afterwards translated into Latin by F. Hessler, a very fair description of cutting for stone “upon the gripe” is given, the method now commonly known as the method of Celsus. It seems doubtful whether the Hindoo method of extracting stone described in the *Sucruta*, was prac-

¹ The Influence of Colloids upon Crystalline Form and Cohesion, p. 61. London, 1879.

² Die Harnconcretionen. 1882.

³ Probably the most masterly treatise upon the history of stone which has been written, is Bégín's edition of the *Traité historique et dogmatique de l'Operation de la Taille*, by Deschamps, which appeared in Paris in 1796.

tised by physicians, or only by certain travelling specialists, as was the case in Greece.

The Chinese are believed to have been acquainted with stone long before the modern era, and Albueasis, among the Arabians, certainly performed lithotomy.

Hippocrates was familiar with the existence of stone. He used sounds and catheters habitually, and described the use of instruments for the detection of stone. But the mortality attending the operations of peripatetic lithotomists was so great that wounds of the bladder came to be looked upon as necessarily mortal, and Hippocrates could not countenance the practice of lithotomy.

In spite of his conservative opposition the operation flourished, however, and Celsus tells how Ammonius of Alexandria, in the third century before our era, proposed that, after the soft parts had been divided, the stone should be cut by an instrument of his invention, if it should prove too large for extraction without injury to the neck of the bladder. From this circumstance, lithotomy takes its name.

Celsus wrote in the first century before our era, and the method of his day, cutting on the gripe, is now often spoken of as his.

The chemical side of the study of stone includes many distinguished names—among them notably Van Swieten, Van Helmont, Scheele, who discovered uric acid in 1776, Bergman, who detected lime in calculi, Wollaston, who discovered, or rather gave a fixed character to, the fusible, the mulberry, and the pure earthy-phosphatic calculus. All of these varieties were described accurately by him in 1797, and he afterwards added cystic oxide to the list. Fourcroy and Vauquelin announced soon after that they had detected urate of ammonium and silica in calculi, and a host of modern investigators in urinary physiology and pathology have helped to make our knowledge of the chemical and microscopical nature of calculous concretions very exact.

Urinary calculus is a term applied to a concretion of more or less stony hardness found at any point along the urinary tract or in a fistula communicating with that tract. The calculus may be formed of crystalline organic matter, of earthy phosphates, of fibrin, of indigo, or of other substance.

It may form spontaneously, or upon a nucleus introduced from without. It may be microscopic in size, or as large as a child's head at term. A minute rounded concretion, smaller than a millet-seed, may properly be called a stone if it shows a laminated structure under the microscope; while clusters of large size composed of a conglomeration of crystals, separate crystals, and sand, may, whatever their size, be properly termed gravel.

This distinction has practical value in connection with the questions of prognosis and of the preventive treatment of stone. In these respects, if the careful scientific researches of Rainey, Ord, and Carter have any value, the distinction is important. For inasmuch as the salts of the urine assume a solid state in the crystalloidal, or in the colloidal form (submorphous of Carter), we have the element upon which to decide, in a given case, whether the tendency to stone formation is great or small. The crystalloidal forms may be somewhat disregarded; the colloidal call for earnest consideration.

Crystals under ordinary conditions in the urine do not unite to form a stone. Something more is necessary. Earthy phosphates also fail to form stone under ordinary conditions. Thompson has called special attention to this, and it has long been a well-known fact that a patient with the so-called phosphatic diathesis may habitually urinate in such a way that the latter part or the whole of his stream of urine is creamy-white with precipitated

earthy phosphates, and yet will never have a stone as long as the mucous membrane of the urinary tract remains free from inflammation.

On this point Ultzmann¹ does not agree with Thompson, but holds that extreme phosphaturia is a factor in phosphatic stone formation. While this may be true in those occasional cases of alkaline stone which contain no ammonia (the pure phosphate-of-lime and carbonate-of-lime stones), it certainly does not hold good for ordinary phosphatic stones—triple-phosphate and fusible calculus—the only true secondary stones. In the formation of these latter, inflammation of the mucous membrane of the urinary tract has always been an etiological factor; and it makes no difference whether the urine has been customarily acid or alkaline, such an inflammation with obstruction to the free escape of urine is efficient to produce an ordinary phosphatic stone.

Other individuals again, at intervals, pass red sand of crystallized uric acid with great freedom, but do not on that account alone necessarily get stone in the bladder.

The element most essential for stone structure is the skeleton of the stone—not so much the solid as the soft part—the colloids, the glue, by which the solid elements are collected and fixed.

GEOGRAPHICAL DISTRIBUTION OF STONE.

It is well known that stone occurs much more frequently in certain districts than in others, but a satisfactory explanation of this fact has not yet been given. The use of hard water for drinking does not explain the matter. Agnew² says that in certain valleys in Lancaster County, Pennsylvania, of limestone formation, the water is very hard, being strongly impregnated with lime, and yet calculus is uncommon; and he joins former writers in the very apposite reflection that it is difficult to understand how calculi—most of which are composed of uric acid—could be formed out of lime. Civiale, whose statistical researches were very thorough, has written:³—

Dr. Warren, of Boston, has recently told me that stone is very rare in Massachusetts, and is almost unknown in those localities where granite rock abounds, while it is found occasionally at other points where the soil is calcareous; but this alleged influence of the nature of the soil upon the production of the calculous disorder is an hypothesis only admitted in order to explain facts, the true cause of which is not evident. Several of the localities from which I have received statistical documents possess the granite formation, but in spite of this, calculus is far from being a rare disorder.

Again, speaking of the stone cases reported from the department of Var, in France, he says:—

The malady seems to be equally divided among all classes of society; the nature of the soil, which is of flint and granite on the coast, and calcareous in the interior, does not appear to make any sensible difference in the distribution of cases.

Cadge,⁴ of Norwich, England, on the other hand, ascribes the great frequency of calculous (uric-acid) disorder in that district to the hardness of the water, and Prout shares his opinion. Reginald Harrison⁵ tries to establish a connection on the ground that hard waters interfere with digestion, and in this way modify the conditions of the solids and colloids in the urine. He mentions the frequency of stone in the young among the poor about Nor-

¹ Op. cit., S. 30.

² Principles and Practice of Surgery, vol. ii. p. 631.

³ *Traité de l'Affectio Calculeuse*, p. 588. Paris, 1838.

⁴ Brit. Med. Journal, vol. ii. pp. 207-212. 1874.

⁵ Lectures on the Surgical Disorders of the Urinary Organs, 2d ed., p. 245. 1880.

wich, and the fact that milk is scarce and dear, and quotes Cadge's assertion that the frequency of stone in children will be found in strict accordance with the difficulty of procuring milk.

Mastin¹ takes the other side, showing that in Kentucky and Tennessee—sandstone districts where the water is very soft—calculous disorders are common, and are just as frequently encountered as in the limestone areas of the same region, where hard water is drunk. No country is exempt from calculous disorder, yet the areas of its prevalence are small. Thus in England, the eastern counties, Norfolk and Suffolk, appear to be most afflicted. It is noteworthy that as many cases occur each year in Norfolk, among its 438,656 inhabitants (Cadge), as in all Ireland with a population of 5,412,377. The northern counties of Ireland and of Scotland furnish more cases than the remaining portions of those countries.

Calculous disease abounds in France, in Teneriffe, in Iceland, and in Egypt. Its frequency in Egypt is said by Roberts² to be due to the presence of the minute urinary parasite, the *Bilharzia hæmatobia*. Stone is also very common in Russia, especially in the central parts of European Russia. Klein³ states that cases of stone sometimes constitute a fifth of all those under treatment in the hospitals of Moscow. Estlander,⁴ on the other hand, shows that primary calculus is almost unknown in Finland, the University Hospital case-books showing only one Finlander with uric-acid stone during a period of forty-four years. There were cases of phosphatic stone with paralyzed bladders, etc.

Civiale⁵ notices a similar immunity in Christiania, where out of 3211 patients in hospital during four years only one had stone, while in the hospital at Gothenburg, in Sweden, a hospital of sixty beds, there had been no stone case in fifty years.

Fayrer⁶ says that stone is very common in the northwestern and central provinces of India, 554 cases having been cut for stone during a single six months in 1863. In Lower Bengal it is rare. Fayrer⁷ says that lithotomy has been performed only about one hundred times in the Medical College Hospital of Calcutta. Harris confirms the fact, and ascribes the frequency of the malady in the Northwestern Provinces to the prevalence of cold winds from the Himalayas, and to the use of a heavy unfermented bread by the natives. Dr. Garden's⁸ testimony from the Sarahunpore Dispensary is corroborative of the frequency of stone in India. Mastin⁹ refers to Curran for authority in stating that Hindostan is exceptionally rich in stone cases. Vandyke Carter¹⁰ speaks for Bombay and the great prevalence of oxalate-of-lime calculi there. He thinks that stone is more common in Western India than in the southern portion.

Mr. Dudgeon,¹¹ of Pekin, informs us that at Canton, in China, and at Takow, in Formosa, calculus is found, but apparently not elsewhere. At Pekin the water is full of lime, at Canton very soft. Kerr¹² also says that Canton furnishes the stone cases of China, and that not a single case was observed among the thousands of patients treated in the missionary hospitals at Hing-po, Shanghai, Pekin, and Hangkow.

¹ Causes and Geographical Distribution of Calculous Diseases. Trans. International Medical Congress, p. 609. Philadelphia, 1877.

² Urinary and Renal Diseases. 2d American ed., p. 275. 1872.

³ Ueber Steinkranheit und ihre Behandlung. Archiv f. klin. Chir., Bd. vi. S. 78.

⁴ Trans. International Med. Congress, p. 663. Philadelphia, 1877.

⁵ Op. cit., p. 580.

⁶ Referred to by Coulson (Dis. of Bladder and Prostate, 6th ed., p. 378).

⁷ Clinical and Pathological Observations in India, p. 385. 1873.

⁸ Indian Annals of Med. Science, 1868, No. 23, p. 20.

⁹ Loc. cit., p. 618.

¹⁰ Calculous Disease in Bombay. St. George's Hospital Reports, 1871-2, p. 85.

¹¹ Calculus in China. Med. Times and Gazette, Sept. 2, 1876. p. 252.

¹² New York Med. Journal, 1871.

In Norway, Sweden, Denmark, Styria, and Spain, stone is not very common. In France and Holland it is abundant; in Austria, Germany, Italy, Syria, and Persia, it is reasonably frequent. In Mexico, Central and South America, and Australia, as far as known, the disease is not common.

Livingstone failed to find syphilis or stone among the natives of Central Africa.

In North America, in the United States, the greatest number of stone cases originate in the central districts—Tennessee, Kentucky, Ohio, Indiana, Missouri, Western Pennsylvania, and Virginia. In Utah it is said to be common. Authorities differ as to Georgia and North Carolina. In the Northern, Eastern, the Gulf, Southern, and Western States calculus is uncommon, as it is also in the Canadas and British possessions. These peculiarities of distribution are not satisfactorily accounted for by any peculiarities of water, food, or climate.

CAUSES OF STONE FORMATION.

First among the causes of stone formation, according to the best modern investigation, must be placed the influence of the colloids. Doubtless such substances as disturb digestion and nerve-force, and furnish an excess of uric acid, of oxalate of lime, of phosphates, as the case may be, favor the formation of stone, but alone they are not sufficient. Undoubtedly also without cystic oxide, urostolith, or indigo, in the urine, calculi formed of these ingredients could not occur. But the fact remains that urates and uric acid may be in excess in the urine for years, and phosphates for a life-time, and no concretions into stone take place, while at a given moment, presumably during a proper co-operation on the part of the colloids, primary (acid) stone starts into existence; or the presence of a foreign body with inflammation of the mucous membrane will speedily give rise to a secondary (alkaline phosphatic) stone in any individual, whether his diathesis be phosphatic or not. The colloid in the latter case is the alkaline mucus furnished by the inflamed mucous membrane.

In 1857, George Rainey first showed at St. Thomas's Hospital that certain crystalline materials assumed globular forms when precipitated in gummy solutions, and he announced his mature doctrine of "molecular coalescence and molecular disintegration" in a short treatise published in 1858, "on the mode of formation of shells of animals, etc." His researches led him to conclude that a law existed by which organized bodies assumed a rounded form on account of physical and not on account of vital agencies. The following was Mr. Rainey's process: a solution of gum arabic saturated with carbonate of potassium, sp. gr. 1.4068, perfectly clear, was placed in a bottle, filling it one third, and two clean slips of glass were introduced into the liquid, touching above, separated below. The bottle was then filled carefully with a perfectly clear solution of gum, sp. gr. 1.0844, and set aside for a month.

In this way Mr. Rainey succeeded in forming perfect spheres of carbonate of lime having all the hardness of pearls, and he demonstrated that they were built up by the slow coalescence of minute molecules.

The spheres showed radial and concentric markings, and a very distinct cross in polarized light. Where two spheres touched, they gradually coalesced into one perfect sphere, and where each sphere came into contact with the glass, a shallow pit formed in the latter, due to a new arrangement of its molecules.

Mr. Rainey concluded that the "viscosity" of the gum destroyed the

polarity of the crystal which would otherwise form, and that the molecules simply obeyed the law of mutual attraction. The gum was intermixed with the lime in the spheres.

When spheres so formed are placed in new solutions of gum of different specific gravity, they lose their laminated arrangement, split radially, and return to the molecular condition, a process termed by Mr. Rainey "molecular disintegration." This splitting of a concretion in a fluid of different specific gravity from that in which it was formed, is beautifully illustrative of what sometimes takes place in the human bladder in the spontaneous fracture of stone.

Rainey obtained similar results by the use of the carbonates of barium and strontium.

Professor Harting, of Utrecht, in 1872, published some original work in the same direction. William M. Ord has followed up Rainey's investigations with some excellent independent researches directed mainly toward investigating the method of formation of urinary and other calculi, publishing the final results of his labors in 1879.¹ Professor F. Guthrie, and Drs. Montgomery, Jevons, Ascherson, and others, have labored in the same field.

Dr. Ord's second proposition is the following:—

"A crystalloid is deposited from solution in the presence of a colloid. This occurs in . . . uric acid and urates mixed with albumen and mucus, in nitrate of urea crystallized from albuminous urine."

The third proposition is—in part:—

"Crystals are broken down and turned into spheres or spheroids, or molecules, by the action of colloids into which they are introduced," etc.

Uric acid exists in three forms:—

1. Rectangular, oblong, colorless plates—pure uric acid.
2. Rhombohedra and its modifications—urinary uric acid.
3. Spherical form—calculous uric acid.

Ord states that No. 1 is the proper crystalline form of uric acid, and that the changes in form which the urinary crystals present (40–50 varieties) are assumed in obedience to Rainey's law of molecular coalescence, and vary with the quantity and quality of colloidal substances which the urine contains. The pure tendency to polarity in the crystals is modified, and mutual attraction of the particles tends to produce curved lines in the crystalline form.

Four substances in normal urine influence the form of crystals: mucus, urea, extractive coloring matter, and salts. To these must be added the ingredients of pathological urine capable of modifying crystalline form: albumen, sugar, blood, and pus. To mucus and purulent mucus seems largely due the rounded form which uric acid assumes, so that by proper experiments Ord was enabled to form small uric acid calculi under his very eye, as it were. Heat intensifies the action of a colloid, and a colloid in partial degeneration seems to be particularly active. Such a colloid is purulent mucus.

"Therefore," says Ord,² "if the causes of the varying prevalence of calculous disease in different communities and regions are to be fully and usefully examined, such subjects as constitutional proneness or indisposition to vesical catarrh, habits of life, diet, and regimen, or local conditions of soil, water, and climate, which can hinder or promote the secretion of mucus or the occurrence of irritation in the urinary tract, must be carefully treated. And if such observations be applied to practice, we may hope to find

¹ The Influence of Colloids upon Crystalline Form and Cohesion. London, 1879.

² Op. cit., p. 61.

that the prevention of stone becomes partly possible through the prevention of the local conditions which constitute the soil in which it is sown and grows."

Ord states that two-thirds of all calculi "are in bulk composed of, or start from, concretions of uric acid." His experiments with colloids and oxalate of lime lead him to believe that to mould oxalate of lime into calculi requires a denser colloid than usually exists in vesical urine. He therefore believes that the beginnings of oxalic calculi usually occur "in the recesses of the kidney among less diluted colloids."

H. Vandyke Carter¹ believes that it is during some febrile condition, or in connection with some irritation along the urinary tract, that calculi originate; the colloid, mucus, pus, albumen, fibrin, and blood being present coincidentally with an excess of the saline ingredient out of which the nucleus is to be composed. He says:—

"I have noticed in the interstices of a nucleus, composed of oxalate-of-lime spheroids and blood, isolated collections of rhomb-crystals, such as experiment shows will appear in a firm colloid in which oxalic acid and lime are caused to meet, and I venture to suppose that in this case a small mass of mucus served as the medium." In his microscopic researches Carter has found that "calculi are habitually surrounded by a thin layer of mucus in which goes on the process of molecular coalescence resulting in the addition of fresh layers."²

RICHNESS OF THE URINE IN SOLID INGREDIENTS.—Excess of solids alone in the urine does not necessarily give rise to stone. Ultzmann³ gives nearly the whole credit in calculous formation to the amount of solids in the urine, notably uric acid. In his investigations he found that about 94 per cent. of all stones had nuclei of uric acid. The element, he believes, which influences stone formation, is the shape of the uric acid crystals. This he found to be modified by the degree of acidity of the solution in which the crystals were deposited, and consequently he assumes that the fan-shaped, sheaf-like masses of pointed, acicular crystals, are the obvious starting points of stone. This assumption is in direct opposition to the conclusions adopted by Ord after the demonstration of experiment.

Ebstein⁴ gives clinical strength to Ord's theories in quoting Frerichs as finding in the tubules of the adult kidney, glomerules of urate of sodium, and in a case of Bright's disease amorphous fibrinous coagula with nodules of brown uric-acid crystals the size of a pin's head—evidently rounded by the colloid, and not sheaf-like. Rounded concretions of uric acid of varying size are not infrequently found in diseased kidneys, in cysts and dilated urinary tubules.

That an excess of uric acid in the urine is the chief cause of stone in infantile life, is doubtless true. The uric-acid infarction of Virchow is a phenomenon nearly constant in the kidneys of young infants. It has been found in infants who have never breathed, but is often absent in such cases, while it is most frequently met with in the kidneys of infants who have lived several days.⁵ These long lines of reddish gritty substance in the kidney-tubules are believed by Ultzmann to be composed in part of urate of ammonium, and in part of urate of sodium. This statement of their exact nature is not uniformly accepted, but all agree that uric acid is a main ingredient in the infarctions, which occupy the straight urinary tubules, filling them up and giving the pyramids an appearance as if they had been injected.

Ultzmann examined the brown dust passed out from these infarctions upon

¹ The Microscopic Structure and Mode of Formation of Urinary Calculi. London, 1873.

² Op. cit., page 40.

³ Ueber Harnsteinbildung. Wiener Klinik, 1875.

⁴ Ziemssen's Handbuch d. spec. Pathologie und Therapie, Bd. ix. H. 2, S. 208.

⁵ Ebstein, loc. cit., S. 216.

the infant's napkins with a No. 10 Hartnack immersion lens, and found them to be composed of masses spherical and dumb-bell in shape. Concentrated urine (as that of intra-uterine life always is), and concentrated colloids (those found in the recesses of the kidney tubules), thus seem to give a rounded (colloidal) shape instead of crystalline forms. It is noteworthy that this brown dust is found more often on the napkins of puny infants than upon those of robust babies.

In examining specimens of kidney-substance after putrefaction had begun, large spherical globules were found in great abundance. Ultzmann does not mention colloids, but his testimony goes largely to sustain the assertions of Ord and Carter. His most recent conclusion is¹ that uric-acid infarctions in the kidneys of the newly born are composed of balls or concentrated groups of fine needles of urate of sodium, which would go to prove that in this sense he is correct in believing that the pointed crystal favors calculous formation.

Uric acid is normally present in all urine to the amount of about 10 grains daily. In the natural condition it is not free, but is in combination with alkaline bases which feebly hold it in solution. Any excess of acid of any other kind, such as the acid phosphate of sodium or (out of the body) lactic acid, from acid fermentation of the urine, combines with the bases of urinary salts, and liberates uric acid.

If now crystallization takes place in presence of the feeble and dilute colloids of the bladder, the crystals assume acicular or rhomboid forms, and are passed as gravel. If, on the contrary, the acid crystallizes in the thicker mucous colloid of the kidney-tubules, it may take the laminated form, and is, from its very origin, a stone ready to gather about itself a film of fresh colloid from the mucous membrane of the urinary tract wherever it may lie, the colloid being furnished by the irritation which the presence of the stone occasions, and ever ready in this film of colloid to attract by molecular coalescence fresh particles of uric acid out of the urine. Finally, the stone may excite inflammation of the mucous membrane, cause an outpouring of stringy mucus, decomposition of urine, and precipitation of phosphates, and then its film of colloid becomes a nidus for the deposit of phosphatic accretions, and secondary or alkaline stone formation goes on.

Oxalate of lime in the same way, when in excess, from the food, or from nervous or other causes, may crystallize in its customary octohedral form, or in the modifying presence of a colloid of mucus, blood, or pus, may assume the dangerous dumb-bell or the spherical shape, and may become at once a possible stone. And so of other substances. The phosphates notably do not precipitate in a shape capable of forming stone, except in the presence of the colloid mucus coming from catarrhal inflammation. Even a foreign body, if unirritating, may remain in the bladder for a considerable period, and no phosphates will precipitate upon it unless catarrhal inflammation be present.

If a small, smooth nucleus gets into a healthy bladder, it may at first excite only enough irritation to surround itself with a film of mucus, in which acid stone formation goes on indefinitely, until the presence of the foreign body excites vesical catarrh, when peripheral deposits of phosphates will take place.

EFFECT OF AGE IN CAUSING STONE FORMATION.—No period of life is exempt from the liability to stone. I have removed, by lithotomy (successfully), from the bladder of a boy of nine, three calculi, weighing collectively very nearly two ounces, which, according to the statement of the mother, had been diagnosed at the birth of the child. Many operators have reported cases

¹ Op. cit., S. 25.

observed shortly after birth. J. W. Troizki¹ extracted from the urethra of a male infant, one month old, a uric-acid stone weighing twenty-five centigrammes, eight mm. long, and five mm. broad. This had formed during intra-uterine life, and had produced acute symptoms when the child was eight days old.

Civiale never saw a case of congenital stone, but he quotes from Brendel that of a child dying two days after birth, in whose bladder a stone of some size was found, and he alludes to two male babies in whom urethral stone was found within twenty-four hours after birth. A. Jacobi² says that he has detected "six cases of congenital renal calculi in forty autopsies," and believes so-called intestinal colic in children to be often renal colic. Langenbeck has settled the whole question of intra-uterine stone by discovering a calculus in the bladder of a male fœtus of six months. This he reported orally to Mr. Coulson. Nearly all surgeons who have dealt with stone, report a greater number of operations upon children than upon adults, and it has been generally admitted that calculus is more common in early than in advanced life. The conditions appropriate for prompt stone formation, as has been shown in connection with the question of the influence of colloids, are amply furnished by the infant, and but for the fact which Coulson has emphasized, that the relative number of young people in the world is so large when compared with the number of adults, it would be fair to conclude that stone was very common in children. This, however, is not strictly true.

Coulson³ has shown by calculations based upon the statistics of Civiale, that the liability to stone, at the different ages of life, when corrected by taking into consideration the number of people alive at different ages, is very different from the apparent liability computed by simply noting the number of cases occurring at different ages.

Thus, while out of a collection of 5376 cases, 2989 were found in persons under 20 years of age, the number of persons living and under 20 years, in a given 100, is 46; so that while the actual liability appears to be 55 per cent., the real liability is below 25 per cent. In the same way, from 20 to 40, the liability is less than half what it is below 20; from 40 to 60, it nearly reaches the liability of youth; while after 60 it is relatively nearly twice as great as it is below 20.

Thus it will be seen that, according to reported statistics, stone is relatively more common after 60 than before 20, and that the period of early manhood is most exempt. This is undoubtedly due to the facts that all infants who have stone are operated upon or die before 20, and that, activity of life and freedom from debilitating agencies prevailing as a rule between 20 and 50, stone does not tend to form readily at this period.

The few who survive 60 are usually more or less feeble; prostatic disease exists in about one-third of the men, and the conditions favoring secondary phosphatic stone are active. If primary (acid) stones were alone computed, the percentage of young persons affected would easily surpass all others.

Gross and Cadge have both called attention to the fact that in some districts stone seems to be more common in children; in other sections in adults; and Thompson is very positive in stating that while among the poor of London the children furnish many cases of acid stone, the old men of the same class of life do not have phosphatic stone.

WATER AS INFLUENCING STONE FORMATION.—The water question has been already discussed in connection with the geographical distribution of stone.

¹ Quoted in *Centralblatt f. Chirurgie*, No. 47, 1881, S. 751.

² *New York Med. Journal*, July 21, 1883, p. 74.

³ *Diseases of the Bladder and Prostate*, 6th ed., p. 369. 1881.

One curious means by which water may prove indirectly to be a source of stone formation, is suggested by a recent contribution on the formation of calculi, by Zancarol,¹ surgeon to the Greek Hospital at Alexandria, Egypt. He says that the natives drink unfiltered Nile water, and imbibe the distoma hematobium, and that the animal and its ova can always be found in the urine and among the layers of stone in the case of the natives, who suffer frequently from calculous disorder. The foreigners, who only drink filtered Nile water, do not often have stone, and their urine does not contain the distoma or its ova.

SEX has undoubtedly an influence upon the frequency of vesical, but not of renal, calculus. Absence of the prostate, the large size and shortness of the female urethra, and the comparative freedom of women from urethral diseases and vesical catarrh, are sufficient almost to secure them immunity. Coulson estimates the relative frequency of stone in females as compared with males at 5 per cent. Prout makes it about the same. Klein, in Russia, puts it at a little over one-fifth of one per cent. Secondary phosphatic stones forming upon foreign bodies introduced from without, seem to be, relatively to the whole number of cases, more common in the female than in the male.

RACE seems to influence stone formation. Gross,² analyzing the lithotomies reported in some of our Southern States, found the proportion to be one in a negro to six in whites. Rayer says that the negro escapes in Egypt, while the Arab suffers. Mastin³ collected 3039 lithotomies in America, and found only 102 put down to the negro, and 31 to the mulatto. Mastin says that gout is seldom if ever seen among the black people of the United States, and he quotes Winterbottom as vouching for the same fact in regard to the native Africans around Sierra Leone.

CLIMATE.—Statistics indicate that climate alone does not influence stone formation. Temperate zones seem to be most afflicted, yet the cold winds of the Himalayas, and the gales at Norwich, have been accused of contributing to the calculous tendencies of those regions. The central districts of the United States, however, are not especially windy; in France, Civiale found the proportion of cases in the Var district the same inland and on the coast. The New England coast is subject to dampness and boisterous northeasterly gales, yet stone is infrequent there.

SOCIAL CONDITION, HABITS, AND OCCUPATION.—These are not prominent etiological factors of stone. Civiale affirms this for France. Soldiers and sailors are reported by all who have given attention to their statistics to be remarkably free from stone, but most soldiers and sailors are between the ages of 20 and 40, and in good general health. Undoubtedly there are more stone cases among the poor than among the wealthy, but the latter class is comparatively small, and nearly all cases of the poor go to hospitals for operation, where they are sure to be recorded, while the wealthy escape tabulation to a certain extent.

In New York there is very little tendency to stone formation. During fourteen years' active surgical work in two of the largest city hospitals (Charity and Bellevue), I have found in my service only two cases of stone. The cases which I have operated upon in hospital have been sent in by myself. Most of my operations have been done in private life.

¹ Rev. de Chir., 10 Août, 1882, p. 645.

² Op. cit., p. 168.

³ Loc. cit., p. 618.

Thompson¹ however “does know any disease which marks more distinctly or more curiously, its relation with class than this. So common is stone in the children of the poor, comparatively speaking, that at Guy’s Hospital, surrounded as it is by a very large neighborhood, densely populated by some of the worst-nourished classes of the community, quite one-half the cases admitted are children. Among the same classes, however, it is rare at the other end of life, very few elderly working men in London being afflicted with it. On the other hand, among the well-to-do and well-fed, while almost never found in childhood, it is comparatively common in advanced age.”

EXERCISE AND FRESH AIR militate against stone formation by thoroughly oxidizing the waste products of the body.

DRINK AND FOOD.—*Alcohol* probably will not produce stone without the co-operation of other predisposing agencies. In large cities all over the world, alcohol is consumed freely, but no statistician has ever noted a special prevalence of stone among dwellers in cities. Much liquor is consumed in Scotland and in Ireland, doubtless as much or more than in England, yet the latter locality is the favorite for stone. Some wines, like the Rhine wines (Sœmmering), being charged with bitartrate of potassium, rather check tendencies to stone, but sweet fermented wines and malt liquors, which increase the amount of uric acid, undoubtedly favor the formation of acid stone.

Food alone cannot materially affect stone formation by its quality. Where the tendency exists, it may be intensified by the nature of the food. Thus in India, Vandyke Carter found oxalate-of-lime nuclei most common in the calculi of the rice-eating natives. But it is not starch as food that causes stone, or the potato-eating Irishman would be prone to stone, which is not the case. Nor is it rice-starch, or the Chinaman would be as constant a stone-producer as the Indian—which again is not the case. In Europe and America, uric-acid stones are the rule, but if a meat diet caused stones, the latter would be much more common in cities, where much meat is consumed, than in the surrounding country where the farmers feed more sparingly on meat—but this again has not been noticed as a fact.

Milk diet has been supposed to oppose the tendency to stone; probably this is true, but it is a minor factor. Indigestion again has been accused of causing stone; but if this were so, surely the disease ought to prevail in New England, where bad teeth and dyspepsia, due to hot bread, pie, and rapid eating, are the rule, and yet where stone is very rare.

CONSTITUTION.—It is probable that gout and rheumatism increase any tendency which there may be to stone, because these diathetic conditions are usually accompanied by acidity of the urine, with excess of uric acid and urates. A gouty individual leading a sedentary life, drinking freely, and eating highly nitrogenized food, especially if he has a little dyspepsia, and is constantly kept anxious about his business or other matters, is in a fit condition to form stone easily. Such patients not uncommonly pass small uric-acid concretions.

ACUTE MALADIES.—Prout, Kletzensky, and Beale have pointed out the tendency to a deposit of oxalate of lime in cholera patients. Any feverish condition furnishes in the accompanying concentration of the urine one of the factors of stone, and some authorities believe that all renal stones have their origin during a febrile state, perhaps of short duration.

HEREDITY.—As gout is hereditary, so are the tendencies to stone. I have at present under observation a family in which three generations, all living,

¹ Clinical Lectures on Disease of the Urinary Organs, 6th ed., p. 67. 1882.

have strong and constantly out-cropping tendencies to the appearance of fine uric-acid gravel. The baby of three years and the grandfather of seventy manifest it about equally.

The most celebrated recorded instance of inherited tendency to stone is that reported by Mr. Clubbe,¹ of Lowestoft, where six children all had stone, the father and mother passed quantities of uric acid, and the grandfather, grandmother, great uncle, six uncles, four aunts, and a cousin—all had had attacks of gravel, or had been cut for stone. Cadge² recently reported a case of stone in a female with sacculated bladder, who asserted that her father had died after lithotrity, and that her brother was then suffering from stone. In several of my own calculous cases the patients, without prompting, have accounted for their stones on the ground that their fathers had had gravel.

It seems to me more than probable that hereditary tendency to stone lies at the bottom of its regional distribution, and accounts for its geographical peculiarities. Generation after generation, growing up in the same region, and intermarrying, would naturally reproduce and intensify any such physical trait. In former years, when locomotion was slow, the few who emigrated married others with different tendencies, and so failed to spread the habit, while those who married others with like tendencies established new areas of stone formation. Food, drink, and surroundings may have intensified or modified these natural physical peculiarities, but that the essence of the geographical distribution of stone (primary, acid stone) lies in intensified hereditary predisposition, seems to me at least plausible in lack of a better explanation. With modern facility and cheapness of locomotion, it seems at least possible that the centres of stone formation may finally be broken up, and that by more general and mixed marriages the disease may become more extended in geographical area, but less active.

CHRONIC DISEASE OF THE URINARY PASSAGES is unquestionably a factor in stone formation. *Stricture of the urethra*, although occasionally complicated by stone, is only so as an exception. Stricture provokes powerful contractions of the bladder to expel its contents. As a rule, the bladder empties itself, and there is generally no physical reason why stone should form. I have encountered stone as a complication of stricture in only three or four instances. *Enlarged prostate*, on the other hand, leads to eccentric hypertrophy and atony. In this condition the patient has residual urine, often in a state of partial decomposition from vesical catarrh, and thus all the conditions necessary for active, secondary, phosphatic stone are present. These conditions exist the world over, and sufficiently explain the great relative frequency of stone in the aged. No case of prostatic disease is fairly treated unless an exploration for stone is made, whether the patient presents any symptoms of stone or not. Diseases of the spinal cord which cause paralysis or atony of the bladder lead to stone (phosphatic), unless the bladder is kept washed out.

FOREIGN BODIES play a chief part in the formation of secondary (phosphatic) stones. The irritation of the foreign body excites more or less catarrh; the urine becomes alkaline, ammoniacal, and partly decomposed; earthy and triple-phosphates are thrown down; and in the colloid muco-pus about the foreign body the phosphatic material stiffens into stone.

A foreign body never becomes encased with phosphatic material until after it has excited catarrhal inflammation of the mucous membrane upon which it rests. The same statement applies to any foreign body anywhere in the

¹ Hereditariness of Stone. *Lancet*, Feb. 10, 1872, p. 204.

² *Lancet*, January 5, 1884, p. 6.

urinary tract, be it a blood-clot, the ovum of a parasite, a tooth, piece of bone, or bunch of hair from an ovarian cyst, a bullet from without, a piece of broken bougie, or any substance introduced by accident or design. Any calculous nucleus coming down from the kidney is as much a foreign body as if it had been introduced through the urethra, and is built upon by the same laws, by acid layers first, and then, after catarrh, by phosphatic layers.

CLASSIFICATION OF URINARY CALCULI.

Calculi as commonly encountered are made up of several ingredients, one of which is always animal matter, a sort of stroma that pervades the mass in which the other materials, crystalline and amorphous, are deposited. The cement-substance is constant and probably uniform in character. Different opinions are held concerning its exact nature. It contains mucus, fibrin, and albumen, but the final word has not been spoken as to its exact composition. Certain microscopic fungous spores and mycelium have also been found and described as part of the organic composition of a stone, but their presence seems purely accidental. The other ingredients which the cement substance holds together are not usually uniform in character—urates, uric acid, and oxalates occurring together in the same stone, and phosphates being perhaps added on the outside.

The nucleus of a stone often differs in composition from the various superimposed layers, but the name of the stone surgically depends upon that ingredient which constitutes most of its bulk. The nucleus and the organic stroma are disregarded. An oxalate-of-lime nucleus in a large concretion of uric acid, surrounded by a thin layer of phosphates, in a surgical sense is a uric-acid stone.

Scientifically this is not accurate, for a calculus owes its existence to its nucleus, and it would be more exact to name the stone according to that nucleus if its composition could be readily determined; and in a certain practical sense also a stone might take its name from its nucleus, because only by determining the character of that nucleus can the special tendency of the patient toward calculus be decided, and possibly a more intelligent preventive treatment instituted. But a stone is often preserved whole for its beauty, and thus the character of its nucleus remains unknown. Moreover, the practical surgical question of most importance when a stone is in the bladder is its hardness, as bearing upon the question of lithotomy or lithotripsy. The substance composing the bulk of the stone decides this question, and therefore, properly, gives its name to the stone.

Among the various classifications which have been proposed, that of Ultzmann,¹ following Heller, is perhaps the most widely adopted and possessed of the greatest merit. It aims at scientific exactness, and deals with the pathological conditions which precede the formation of stone. In this classification the nucleus names the stone, and although sometimes the surgical name of the stone differs from its scientific name as decided by this method, yet, purely for purposes of study, a classification by the nucleus can hardly be improved upon.

But Ultzmann² in his latest utterances gives up his former classification on the ground that primary stones may form in the bladder, as well as in the kidney, and secondary stones in both regions. He offers no fitting substitute and I therefore prefer to modify his former classification so as to cover all

¹ Ueber Harnsteinbildung, S. 156. 1875.

² Die Harnconcretionen, S. 15. 1882.

cases, and to retain it thus modified. Ultzmann's classification was the following:—

1. *Primary stone formation.*
2. *Secondary stone formation.*
3. *Metamorphosed stones.*

1. *Primary stone formation* of Ultzmann includes stones forming in acid urine, which is normal as far as any inflammatory exudation derived from the tissues is concerned.

2. *Secondary stone formation* includes stones forming in neutral urine—such as the crystalline phosphate and the carbonate of lime, and in urine rendered pathologically alkaline by the products of inflammation of the mucous membrane lining the urinary tract—the phosphatic stones.

3. *Metamorphosed stones*, according to Ultzmann, are certain large kidney and bladder stones with uric-acid nucleus and phosphatic shell. It is claimed that an acid stone lying for years in purulent urine loses its acid crystals, in part or wholly, their place being supplied by alkaline phosphatic precipitates. This metamorphosis of stone is a pure assumption, and Ultzmann does not prove it, or seriously attempt to do so, in either his monograph on stone formation, his work on urinary analysis written with Hoffman, or his pamphlet on urinary concretions. In the last work he does not mention the subject.

It is not uncommon to find a phosphatic stone with a nucleus of uric acid, and it is much more reasonable to suppose that the nucleus, acting like any other foreign body, has produced catarrh of the mucous membrane, and has then become covered with phosphatic incrustation, than it is to believe that the stone has ever been composed entirely of uric acid, and has become partly metamorphosed into a phosphatic stone. This assumption holds as well for the pelvis of the kidney as for the bladder.

Another fault of Ultzmann's classification is, that it places the phosphate-of-lime and carbonate-of-lime stone in the secondary class, and assigns no reasonable position to indigo, urostealith, or fibrin.

I think that the division into primary and secondary stones is an excellent one, with this understanding, that primary stones are such as form primarily from altered urine and colloids, while secondary or symptomatic stones follow as a consequence of inflammatory lesions of the mucous membrane of the urinary tract, without regard to the condition of the urine in respect to its various salts.

Only two stones give any trouble in the classification which I propose: urostealith and amorphous phosphate of lime. I rank them both with secondary stones, because amorphous phosphate of lime, when found at all as a separate stone not combined with the ammonio-magnesian phosphate, is a friable, mortar-like mass entangled in a magna of mucus, and although phosphate of lime is found where there is no catarrh of the urinary passages, yet it is doubtful whether a stone ever forms from it except in the presence of such catarrh.

Urostealith again has never been encountered except in association with mixed phosphates. It therefore seems probable that it only forms in the presence of catarrhal inflammation.

The classification then which I propose is as follows:—

I. *Primary stone*—the mucous membranes of the urinary tract being sound when the stone forms—uric acid (urate of sodium, potassium, lime), oxalate of lime, cystine, xanthine, carbonate of lime, crystalline phosphate of lime, indigo.

II. *Secondary or symptomatic stone*—the mucous membrane of the urinary passage being in a catarrhal state at the point where the stone forms—urate

of ammonium, triple phosphate, amorphous phosphate of lime, fusible calculus, urostealith.

STRUCTURE OF STONES AND NATURE OF NUCLEI.

All true calculi are composed of a nucleus, single or multiple, and layers more or less concentric of the same or another material arranged around it. This is the case for large as well as for microscopic calculi, those requiring a magnifying power of 250 diameters (Beale)¹—Hoffman says 200²—to make out their lamination. This fact of lamination alone differentiates calculus from gravel, the latter being crystalline dust or concretions of crystals more or less large, but not possessed of definite structural arrangement.

The nucleus of a stone may consist of whatever, among the organized, crystalline, or earthy constituents of normal or pathological urine, is capable of concreting into a more or less solid mass; or it may be a foreign substance coming from within the body, or introduced from without.

Among the familiar examples of nuclei are separate rhomb-crystals of uric acid and clusters of them; spheres of uric acid; dumb-bells of oxalate of lime, urates, etc.; a lump of inspissated pus, mucus, or blood, perhaps drying out and leaving a central cavity in its place; lumps of tissue-débris (casts, epithelium, fibrin); eggs of entozoa; portions of bone, teeth, or hair, which have escaped from a neighboring dermoid cyst by ulceration into the bladder; bullets, shreds of clothing, and other foreign matter shot into the bladder; portions of bone from fractures of the pelvis; foreign material from the rectum entering the bladder through fistulous communications; portions of catheters, etc.; and, finally, foreign bodies in endless variety which have been introduced through the urethra, usually under the impulse of depraved erotic fancies.

Ultzmann's celebrated collection of 545 single vesical calculi gathered from various quarters, for the purpose of examining the nuclei, yielded 441, nearly 81 per cent., in which the nuclei were composed of uric acid, while from a further study of multiple calculi and those passed spontaneously he concluded that among primary stones the nucleus was composed of uric acid in 94 per cent.³ Hoffman and Ultzmann declare, in their work on the analysis of urine,⁴ that 90 per cent. of urinary calculi have uric-acid nuclei. Ord⁵ states that two-thirds of all calculi (this estimate includes secondary stones) "are in bulk composed of, or start from, concretions of uric acid."

From the specimens in the museum in Guy's Hospital, Golding-Bird finds the percentage of nuclei of uric acid and urates to be less than 50. In considering the question of nuclei entirely apart from the nuclei of large stones, it must be remembered that a great number of acid nuclei are voided by the urethra; the patients passing them do not enter hospital, and their minute calculi do not find their way into museums.

Roberts estimates that uric acid forms five-sixths of all primary calculi. Klein found that alternating calculi were most common in Russia, the nucleus being for the most part uric acid or urates, quite often covered with a layer of oxalate of lime. Beale states that two-thirds of all calculi in the different British museums are composed of uric acid,⁶ that dumb-bell crystals of oxalate of lime are frequently found as the nucleus of uric-acid calculus, and

¹ Kidney Diseases, Urinary Deposits, etc., 3d ed., p. 405. 1869.

² Hoffman und Ultzmann, Anleitung zur Untersuchung Harnes, Zweite Aufl. S. 109. 1878.

³ Op. cit., p. 149.

⁴ American translation, p. 264. 1879.

⁵ Op. cit., p. 60.

⁶ Kidney Diseases, Urinary Deposits, and Calculous Disorders, 3d ed., p. 409. London, 1869.

sometimes a hollow space representing a former clot of mucus or of blood. This latter phenomenon has been recorded by many observers. The well-known case of the Archbishop of Paris, referred to by Coulson and others, in which Frère Côme predicted before operating that the stone inclosed a clot of blood, illustrates probably one stage of calculus with a hollow nucleus. The archbishop had formerly been a victim to hæmaturia, and Frère Côme's guess was verified by the result.

A remarkable instance of calculus containing a cavity was presented to the London Pathological Society by Mr. Shaw. The stone, composed of uric acid, was as large as a small walnut, but seemed very light. On section it was found to be a shell varying in thickness from a sixth to half an inch, inclosing a large cavity, which latter contained a stone as large as a pea. Doubtless the small stone had become surrounded with a clot of muco-pus upon which uric-acid crystals had precipitated, and after the shell had formed the soft centre had shrunk away.¹ Mr. George Lawson² reports a calculus removed by lithotomy from a man of forty-eight. It was $2\frac{1}{2} \times 2 \times 1\frac{1}{2}$ inches in its various diameters. It weighed four ounces less sixty grains. Its surface was smooth, yellowish-white, and inodorous after being washed. Its composition was phosphatic. On making a section, a drachm of reddish-brown, stinking, ammoniacal fluid escaped. The true nucleus turned out to be a mulberry calculus, ragged in outline, seven-eighths of an inch in its two chief diameters. This nucleus lay in a free space which had been filled with the reddish-brown fluid. Mr. Lawson's explanation is the obvious one; that the rough mulberry calculus when free in the bladder had at last excited catarrh, that its interstices had become filled and surrounded by muco-pus mixed with ammoniacal urine, that this smooth surface had then become encrusted by concentric phosphatic laminæ, and that the inclosed contents had still further retrograded into the brownish putrid liquid. Carter found oxalate of lime to be a more common ingredient in stone formation in India than in England.³ This he ascribes to the vegetable character of the food. The nuclei he found to be composed of uric acid and urates in 50.30 per cent. at Grant College, Bombay, while in England from his sources of information he makes the percentage of stones having uric acid or urates as nuclei as high as 74.46.⁴ Oxalate of lime, on the other hand, formed the nucleus in 38.65 per cent. at Grant College, while the English sources yield only 16.87 per cent.

Carter, from his Indian researches, concludes⁵ that globular urates very often accumulate to form the nucleus of stone; that oxalate of lime in sub-morphous form is very common; but that crystals of uric acid "comparatively seldom compose the nucleus of a calculus." Dumb-bell crystals of oxalate of lime are conspicuous for their frequency among the spicular, granular, and globular urates when the latter occur as the nucleus of stone.

As to structure, Carter's microscopic researches confirm the conclusions of Ord. The albuminous substance is the skeleton in which the solid material forms. Dissolving out the latter leaves the former quite perfect, in some cases, showing the fibrillated radial structure of the basis-substance. In this substance crystals and granules are deposited, the former assuming a peculiar crystalline arrangement (sub-morphous), while the latter undergo remodelling. This arrangement of the basis-substance in a fibrillated, radial manner is very similar, as Ord has pointed out, to the structure existing in the crab's shell as described by Mr. Rainey, and serves, according to Ord, to prove the sound-

¹ Trans. Path. Soc. Lond., vol. vi. p. 251.

² Lancet, March 31, 1883, p. 545.

³ Calculous Diseases in Bombay and some other parts of India. St. George's Hosp. Reports, 1871-2, p. 85.

⁴ The original paper makes these figures 71.79.

⁵ Microscopic Structure, etc., of Urinary Calculi, p. 29. 1873.

ness of the doctrine of molecular coalescence as applied to the formation of calculi.

RATE OF GROWTH OF URINARY CALCULI.

Compact acid stones—uric-acid, and oxalate-of-lime—generally form slowly. Gross cut a man who had had symptoms of stone for twenty-six years, and the calculus was only as large as a hen's egg. I removed two ounces of acid stone from a boy of nine. No fixed rate can be named, the increase being doubtless mainly dependent, in acid stones, upon the proportion in the urine of the ingredient which is being deposited. The estimates of Meckel that primary stones gain from two to six lines in diameter yearly, and of Gross that the increase is from one to four drachms yearly, are little better than guesses.

Ultzmann attempted scientifically to establish the rate of growth for primary stones by keeping them in acid urine which he renewed daily. He found that a number of small stones so treated in his own urine weighed on an average ten times as much at the end of the year as they did at the beginning. He concludes that the rapid rate of increase can only hold good in the case of small stones.¹

Phosphatic stones grow more rapidly, as a rule, than acid stones, but they increase at a varying rate, the grade of the catarrhal process probably having more to do with it than anything else. I removed a hair pin from a young girl's bladder where it had remained unmolested for more than a year, yet it was encrusted with less than a drachm of phosphatic deposit.

Poulet² refers to a calculus, removed by lithotomy, which weighed two and a half ounces, and which had for its nucleus a soft catheter introduced by the patient ten months previously. This patient undoubtedly had had catarrhal cystitis, with atony and retention, for which he had introduced the catheter in the first place. Hence the rapidity of stone formation. Robert Abbe³ removed by lithotripsy, from a man of 70, an entire soft catheter and phosphatic material with which it had been encrusted. The phosphates only weighed forty grains, although the catheter had been in this old man's bladder for seven months. These instances are sufficient to show the irregularity of the rate of growth of stones of either class.

GROSS CHARACTERS OF URINARY CALCULI.

Calculi present peculiarities in shape, surface, color, size, weight, consistence, and number.

Shape.—Calculi are ordinarily oval or rounded in form, and more or less flattened.

Ultzmann argues⁴ that the shape of any single stone forming in the bladder, the growth of which is not interfered with by accidental causes, is regulated by the system of crystallization to which belong the original crystals out of which the stone is composed. Thus uric-acid, phosphatic, and cystine stones are naturally of the flattened-oval type, having three main diameters, because their crystals tend to assume rhomboidal forms possessing three diameters. The oxalate-of-lime crystal belongs to the quadratic system, with two axes nearly equal; hence these stones are globular. Calculi show facets, if a num-

¹ Op. cit., p. 162.

² Treatise on Foreign Bodies, etc., American translation, vol. ii. p. 155. 1880.

³ Medical Record, December 24, 1881, p. 705.

⁴ Die Harnconcretionen, p. 9. 1882.

ber of them have been lying together, and if formed upon a foreign body they often approximate the shape of that body. They are found with hour-glass constrictions—notably where one part of the stone is encysted and another part free in the bladder, and very fantastic, branched shapes are often assumed by renal stones and by vesical phosphatic stones, which branch off sometimes into the ureter and sometimes into the urethra.

Surface.—The surface of a calculus may be as smooth as glass, but it is generally rough. This is especially the case in oxalate-of-lime calculi. Phosphatic stones are sometimes quite smooth, sometimes worm-eaten on their surface.

Color.—Calculi vary through nearly all shades, from white through yellow to brown with tints of green, up to dark brown, nearly black. The color depends mainly upon urinary pigments, not upon admixture with blood.

Size.—Calculi vary from microscopic size upwards. The largest I have seen is the kidney stone removed after death by MacGregor.¹ It measured $16\frac{5}{8}$ by $12\frac{1}{2}$ inches in its two circumferences. Several others, vesical stones, of about the same circumference have been recorded. A stone one inch in diameter is considered surgically a medium-sized stone (Thompson), all below being small, and all above large.

Weight.—This also varies from a fraction of a grain upwards. Gross refers to stones extracted by lithotomy, weighing as little as four, five, six, eight, or ten grains. Gross and Coulson have each removed a five-grain stone, and Ashhurst one of less than two grains, from a boy, by lithotomy. On the other hand, stones have been found weighing 50 ounces (MacGregor's weighed in the fresh state 51 ounces), while there is one stone on record, said by Coulson to have been in the possession of the French lithotomist Morand, which weighed 6 pounds and 3 ounces. The largest stone ever removed from the bladder successfully, of which I find any record, was a stone of over 20 ounces, removed after fragmentation by Dunlap, of Springfield, Ohio,² from a man of 66. The patient lived nearly three years after the operation. Pulido's scrotal stone of $23\frac{1}{2}$ ounces occurred in a successful case, and Gracfe's 26-ounce scrotal stone in another.

The largest stone which was ever extracted from a living person, as far as I can ascertain, was a phosphatic concretion measuring 17 inches around its largest circumference, and weighing $40\frac{1}{2}$ ounces. This enormous mass was removed from a man of 39 by the supra-pubic operation. Uytterhoeven, of Brussels, was the operator. The patient died eight days afterwards. Leroy d'Étiolles records the case.³

Among other cases of very large stone removed by the supra-pubic operation—with a fatal result in each and every instance—are the often-quoted historical examples of Vitellius, 22 ounces, and Deguise, 31 ounces, as well as the more recent ones—also fatal—of Monod, 346 grammes (nearly a pound), and of Després, the elder, two pounds.⁴

A rather large stone of pure cystine, and notable on that account, with diameters $2\frac{1}{2} \times 1\frac{3}{4} \times 1$ and a circumference of 7 inches, weighing a little more than $2\frac{1}{2}$ ounces, is recently reported⁵ to have been successfully removed by John Treameane, in Australia, by the high operation.

Consistence.—Oxalate of lime forms the hardest variety of stone. It is difficult to break, and fractures in angular fragments from the centre. The phosphatic calculi form in flakes and in a mortar-like mass. They are nearly

¹ Am. Journal of Med. Sci., Jan. 1877, p. 120.

² Gross's System of Surgery, 6th ed., vol. ii. p. 752.

³ Traité pratique de la gravelle, etc., 2e éd., p. 95. Paris, 1869.

⁴ Bull. de la Soc. de Chir., 5 Déc. 1881, p. 758.

⁵ Australian Med. Journ., and Journal of Am. Med. Assoc., Dec. 8, 1883, p. 649.

always rather soft, but are sometimes quite hard. Cystine calculi have a waxy consistence.

Number.—Often single, calculi may be as numerous as in the case of Murat, alluded to by Coulson, who vouches for 678 stones in the bladder and 10,000 in the kidneys of an old man. Physick extracted over 1000 stones¹ from the bladder of Chief Justice Marshall, of the Supreme Court of the United States. None of these stones was larger than a bean.

Dr. Ellis Blake, of New York, once showed me the bladder of a woman, distended to about the size of a small fist, absolutely full of stones about the size of duck shot. They were not counted. This patient, during life, had passed these minute stones freely. Sometimes they would drop from her as she moved about. Oxalate-of-lime calculus is rarely multiple.

SPONTANEOUS FRACTURE OF CALCULI.

The spontaneous fracture of calculi within the bladder has been explained by Ord.² Other observers had already written concerning it,³ but their theories of its cause are less satisfactory than that given by this writer.

Ord examined a number of specimens from various sources, and reported upon them to the London Pathological Society. He believes that the splitting is due to the imbibition, by the mucous cement of a calculus, of urine of different reaction and specific gravity from that in which the stone was originally formed. He quotes the paper of Southam⁴ giving two cases observed by that surgeon, one by Luke, and one by Liston, and a drawing of a calculus from the Musée Dupuytren, in Paris. Southam thought that the rupture was effected by the development of gas within the stone, but Ord believes that the internal force is the swelling of the colloid nucleus by the imbibition of fluid different from that in which the stone was formed. This swelling of the nucleus, Ord⁵ says, acts as a "bursting charge in a shell." Coulson has recorded a case, where, according to his belief, two soft calculi crushed each other by mutual friction. Liston's calculus is supposed to have broken up under the influence of violent bodily shock. Ord has collected a number of cases in which the swelling of the nucleus alone could account for the disintegration. He also, in another place,⁶ records an example of molecular disintegration of a calculus, as shown in a stone taken after death from the kidney.

Ord concludes⁷ that the spontaneous fracture of calculi may be due to the action of three causes: (1) Forces arising within the calculus itself. (2) Molecular disintegration. (3) Weakness of some of the alternating layers within the outer shell of the calculus.

When a calculus undergoes spontaneous rupture within the bladder, each fragment, unless expelled, becomes the nucleus of a new stone. In this way, Ord believes, some examples of multiple calculi take their origin. His⁸ most recent expression on this subject is a report upon Smith's case, in which he found spores and mycelium, and in which he thinks that the fungus may have had something to do with the disintegration.

¹ Gibson, *Institutes of Surgery*, 5th ed., vol. ii. p. 220.

² *Trans. Path. Soc. Lond.*, vols. xxviii. p. 170, xxix. p. 161, xxx. pp. 314-320; and op. cit., p. 93.

³ Otto Schmidt, *Beiträge zur chirurgischen Pathologie der Harnwerkzeuge*. Leipzig, 1865; quoted by Gross (*Practical Treatise on the Diseases, Injuries, and Malformations of the Urinary Bladder*, etc., p. 215).

⁴ *Brit. Med. Journal*, vol. i. p. 3. 1868.

⁵ *Ibid.*, Sept. 7, 1878, p. 347.

⁶ *Trans. Path. Soc. Lond.*, vol. xxxi. p. 185.

⁷ Spontaneous Disintegration of Calculi. *Brit. Med. Journal*, May 10, 1879, p. 702.

⁸ *Trans. Path. Soc. Lond.*, vol. xxxii. p. 304.

MATERIALS WHICH ENTER INTO THE COMPOSITION OF URINARY CALCULI.

The colloidal, albuminous, fatty, epithelial, purulent, extractive, and coloring matters found in varying proportions in calculi, as well as foreign substances introduced from without or coming from within the organism and forming nuclei, may be disregarded in considering the present question. Such substances as the urates of lime, magnesium, potassium, and sodium, and the carbonate of magnesium, which may occur in minute proportions mixed with other ingredients of a calculus, only call for casual mention, as well as the earthy matters found as a trace—silica (Berzelius, Vauquelin, Fourcroy, Venables, and others), iron, myeline, hæmatoidin (Ultzmann), and cholesterine. When a calculus is found to be formed largely of cholesterine, it is fair to suppose that a gall-stone has found its way into the urinary passages. An interesting article by Ludwig Güterbock¹ details a case of extraction by lithotripsy from the bladder of a middle-aged woman, of a number of calculi weighing thirteen grammes, composed of cholesterine, with a little uric acid deposited in an outside layer about each calculus. This patient denied having had any previous malady, and the stones were too large to have been introduced from without through the urethra. No biliary constituents were found in solution in the urine, and, as the patient recovered, it was not learned how the gall-stones had reached the bladder. Güterbock refers to two cases previously reported, those of Faber and Pelletan (both in women). In the former, an autopsy demonstrated a communication between the gall-bladder and urinary bladder. Pelletan's patient had suffered pain in the right side for some time before the two hundred faceted gall-stones escaped by the urethra—which they did in a period of eight days—but in Güterbock's case nothing pointed to previous biliary complications.²

The substances which form urinary calculus, constituting the bulk of the mass or well marked laminæ, are the following:—

¹ Gallensteinconcremente in der Harnblase, Archiv für path. Anat. u. Phys., Bd. lxvi., Hft. 3, S. 273.

² Prostatic concretions are not urinary calculi. Their consideration belongs to another article. Fecal calculus, so called, has been described, among others, by R. Williams (Lancet, Oct. 1, 1881). A small vesico-rectal fistula existed in an old man with large prostate. Cancer of the bladder with perforation was diagnosed. After death, ten drachms of hard, solid, fecal material was removed from the bladder, not coated with phosphates. No cancer was found. James Miller (Edinburgh Medical Journal, 1829, vol. xxxi. p. 61), in a letter to Liston, describes a curious fecal and urinary calculus as large as a turkey's egg, which he extracted from the rectum of a child who had been operated upon for imperforate anus, and in whom a communication existed between the rectum and bladder. The stone had to be bored into and crushed, and the anus and rectum freely incised, before the calculus could be removed. The stone consisted of a nucleus of primitive greenstone which the boy had swallowed, a coating of the fibrils of the pencil of oats, such as Wollaston found in the spongy portion of human alvine concretions in Scotland, and an outer coating, from half to three-fourths of an inch thick, of urinary mixed phosphates. Miller refers to a rectal concretion described by Marcet (Essay on Calculous Disorders, p. 126), as found in the rectum of an infant born with imperforate anus and having also a recto-vesical fistula. This stone was composed of mixed phosphates.

Among the irregular substances found as calculi, stones introduced from without must not be lost sight of. Under the title "De la gravelle urinaire simulée et de ses rapports chez la femme avec l'hystérie," Brongniart has collated twenty histories of cases full of curious interest in the Ann. des Org. Génito-Urinaires, Nov. 1883, p. 747.

Urinary calculi in animals are occasionally reported. Ebstein's recent scientific treatise on the Nature and Treatment of Urinary Calculus (Wiesbaden, 1884), discusses this subject quite fully. The Trans. Path. Soc. Lond., vol. xxxiv. p. 326, refers to a stone taken from the bladder of an ass and one from the bladder of a dog, both of carbonate of lime. I have a small box full of minute calculi of carbonate of lime, passed by a bull. Dr. D. G. Sutherland, of East Saginaw, Mich., presented me with a portion of a five-ounce urinary calculus of carbonate of lime cut from a mare on January 24, 1884. The animal survived. Mehu gives the analysis of four calculi of carbonate of lime from the bladder of a rabbit in Ann. des Organes Génito-Urinaires, t. i. No. 7, 1883, p. 454.

OF VERY COMMON OCCURRENCE.

1. Uric acid.
2. Oxalate of lime.
3. Mixed phosphates (lime, ammonium, magnesium).

OF LESS COMMON OCCURRENCE.

4. Urate of ammonium.
5. Ammonio-magnesian phosphate.
6. Phosphate of lime.
7. Carbonate of lime.
8. Cystine.

EXCESSIVELY RARE.

9. Xanthine.
10. Fibrin.
11. Urostealith.
12. Indigo.

Any of these substance may occur as the chief constituent, but one or more may also be deposited in the same calculus forming superimposed layers, the *alternating calculus*. Generally, for obvious reasons, the phosphates form the outermost layer. The layers indicate the condition of the urine at the time each was being formed. According to Coulson,¹ *alternating calculi* constitute almost fifty per cent. of all specimens found in museums. Cystine, xanthine, urostealith, indigo, and fibrin, always stand alone, and do not form alternating layers in calculi—but any one of them may act as a nucleus and become coated with phosphates. Urostealith is only found in company with the phosphates, while indigo has been observed by Ultzmann in crystalline form, included in or surrounding deposits of uric acid and oxalate of lime. Fibrin, as blood clot, is not very uncommon as a nucleus of a calculus—even a primary calculus.

DESCRIPTION OF THE VARIOUS TYPES OF URINARY CALCULUS.

URIC-ACID CALCULUS is the most common form encountered in the human subject. It was described in 1776 by Scheele.

The calculus of old men with enlarged prostates is an exception to the rule, being most often phosphatic. The uric-acid stone may be composed almost exclusively of uric acid, or may be mingled in its intimate structure, or in alternating layers, with more or less oxalate of lime and different urates. It is generally oval, rarely very large, and sometimes quite smooth, though more often granular or smoothly tuberculated. In color it varies from a light fawn (Owen Rees has seen a uric-acid calculus perfectly white) to a brownish or even a blackish-red. The so-called pisiform uric-acid calculus is a pea-like body, often possessed of many facets, occasionally single, generally multiple, and often of a pale yellowish-white color from a coating of urate of ammonium. Of this kind are commonly the stones passed at intervals by gouty patients during a series of years.

Section discloses two forms of structure in uric-acid calculi, the laminated and the amorphous. A given stone may contain layers of both forms.

The *laminated uric-acid calculus*, when cut through the centre and polished, resembles an agate. It displays a concentric arrangement of regularly curved lines of slightly varying color and thickness, looks crystalline when broken, and takes a high polish. Radiating lines are often observed upon it, extend-

¹ Op. cit., p. 341.

ing from the centre to the periphery. The stone is generally very hard. It breaks with a loud noise, upon the application of sufficient force, into angular fragments along its laminae and radiating lines.

The *amorphous uric-acid calculus* is generally of a dirty reddish-yellow color, looking gritty, structureless on section or fracture, perhaps presenting radiating lines from the centre. Sometimes it is found with a radiating crack, indicating a tendency to spontaneous fracture, which is said to be more common in this than in the laminated variety. This form is sometimes quite soft, and breaks into irregular, angular fragments.

OXALATE-OF-LIME CALCULUS, OR MULBERRY CALCULUS, was described by Wollaston in 1797, and occurs next in frequency to uric-acid stone among primary calculi. It is generally round, occurs singly in the bladder, and rarely exceeds the size of a nut. It is usually covered with blunt asperities—whence the name—and varies in color from dark gray through brown to black. Sometimes the asperities are crystalline, small, sharply angular, and shining. The oxalate-of-lime stone is commonly mixed with more or less uric acid, the different urates, and some carbonate of lime, with, often, a certain amount of blood. The blood comes from the mucous membrane of the bladder, irritated by the asperities upon the stone, and, lodging in the depressions between these asperities, it becomes incorporated with the stone. The same roughness often sets up more or less catarrhal inflammation of the bladder, and leads to a peripheral deposit of phosphates.

Hemp-seed calculus is a sub-variety of the oxalate-of-lime stone. It occurs in the kidney, and is a rounded, smooth, brown-colored body, somewhat resembling a hemp-seed. It is generally of mixed composition, containing oxalate and phosphate of lime in different proportions.

Other varieties of oxalate-of-lime calculus have been noted. Dr. Yelloly describes one of a white or pale-brown color, and crystalline in structure throughout. Mr. Poland¹ refers to this, and speaks of an oxalate-of-lime calculus which he extracted, pale-brown in color, which immediately crumbled, there being little or no animal matter in its composition; and still another variety has been described by Mr. Charles Williams, a milk-white calculus of highly polished surface, generally encountered in the kidney, and having no crystals on its surface, but sometimes spinous projections.

Oxalate-of-lime stone is excessively hard, and resists the lithotrite more than any other calculus. It breaks with a sharp report into jagged, angular fragments. On section it shows concentric laminae, deposited in undulating lines about the nucleus. The layers vary through shades of light yellow and brown, to greenish or blackish-brown.

MIXED PHOSPHATIC OR FUSIBLE CALCULUS.—This is the variety of stone produced by catarrhal changes in the mucous membrane with which the urine lies in contact. It is this phosphatic material which encrusts ulcers, tumors, and foreign bodies in the bladder. It forms the phosphatic layers about other varieties of stone, and is the concretion commonly encountered in cases of enlarged prostate. In the total list, all stones considered, the fusible calculus stands second, being estimated to form one-twelfth of the total number, against one-seventeenth for oxalate-of-lime stones and five-sixths for those of uric acid.

The fusible calculus was described by Wollaston in 1797. It is dull, dirty-white in color, varying in bulk from pin-head size up to that of enormous masses, filling the bladder and weighing several pounds. These stones are

¹ Holmes's System of Surgery, vol. iv. p. 1024.

for the most part multiple, showing facets from mutual contact. When single, their shape is not generally symmetrically round or oval, but irregular in some way. These are the stones that grow in a branching manner from the bladder into the prostatic sinus, into the ureters, and into sinuses and sacculi. Quite often, in fusible calculus, the nucleus is not central.

This variety of calculus is often light, soft, and mortar-like, crumbling readily under the lithotrite. It breaks into irregular pieces or in laminae, and is more or less hard, according as the triple-phosphate or the phosphate of lime prevails in its composition. So also its structure varies. Some specimens are white and structureless, others amorphous and crystalline, and others again laminated, and exhibiting triple-phosphate crystals between the slightly adherent laminae.

URATE-OF-AMMONIUM CALCULUS, discovered by Fourcroy and Vauquelin in 1798, and described particularly by Prout in 1823, is yet a subject of some discussion. Roberts thinks that it may be doubted "whether the calculi described by Prout as urate-of-ammonium, were really anything more than fawn-colored uric-acid." Yet observers agree that the urate of ammonium does occasionally occur as a calculus, mainly in the kidneys and bladders of children. It does not reach a large size, and is flattened, oval, smooth, or granular, and slate-gray or clay-colored. Its structure is close and finely laminated, but the laminae are so intimately united that the fracture often looks amorphous. The laminae, however, are easily separable. The stone is brittle and is suitable for lithotripsy.

AMMONIO-MAGNESIAN PHOSPHATE.—This substance, also discovered by Wollaston, in 1797, and commonly called triple phosphate, occurs occasionally as the main constituent of a calculus. It is rare to find it alone, but common as a layer in an *alternating calculus*, or combined with phosphate of lime in the *fusible calculus*. Sometimes alone it forms a secondary calculus upon a foreign body as a nucleus (Bryant).

Calculi of triple-phosphate are white, unevenly round, rough, and crystalline on the surface, chalky and crystalline in texture, and not laminated. They become dulled in appearance when dry and old. Their bulk varies from a minute size up to that of very large concretions, weighing many ounces. Thompson speaks of one weighing nearly two pounds. They are very friable, and excellent objects for the lithotrite. The mass is made up of stellate, bibasic phosphate, and of neutral, ammonio-magnesian, phosphatic prisms (Wollaston).

PHOSPHATE OF LIME, quite common in combination (*alternating and fusible calculus*) is very rare as the main ingredient of a stone. Wollaston described this substance in 1797. Two forms are mentioned: (1) renal, (2) vesical.

The *renal* phosphate-of-lime calculus is pale-brown, smooth, oval, and small, composed of neutral phosphate of lime, and made up of loosely united laminae, sometimes showing radial markings. The material is soft and friable, and the laminae easily disconnected. These stones contain a large proportion of animal matter. The neutral phosphate fuses with the blowpipe.

The *vesical* bone-earth phosphatic calculus is very rare. It is a mortar-like substance, semi-crystalline, entangled in a magma of mucus. The basic phosphate of lime is not fusible with the blowpipe.

CARBONATE-OF-LIME CALCULUS.—This form, although common in herbaceous animals, is rare in man. Carbonate of lime not infrequently occurs as an ingredient in the oxalate-of-lime and in the phosphatic calculus. As the

main element of stone it is exceedingly rare, except in the case of prostatic concretions.

The carbonate-of-lime calculus was first described by Brugnattelli, in 1819. It forms in the kidney as a rule, and is generally multiple. Among the most noted cases are those of Haldane, Hunstone, and Waggstaffe, all carefully described by Roberts, who personally made a careful study of the specimens passed from the patient under the care of Mr. Hunstone. In Hunstone's case, says Roberts, "myriads of minute calculi of carbonate of lime were voided with the urine," "the largest of which were about the size of poppy-seeds, and the smallest only just visible to the naked eye as bright specks." Waggstaffe's carbonate-of-lime calculus was a "large branching calculus" taken from the kidney after death.

Usually these calculi are small, rarely larger than a nut. They may be white and friable (Prout), but are generally gray, yellowish, brownish, or even reddish, or bronzed, or amber-colored, and quite translucent (Roberts). They are exceedingly hard, and on section show a varying arrangement of curved lines about one or more nuclei, resembling in structure the mulberry calculus.

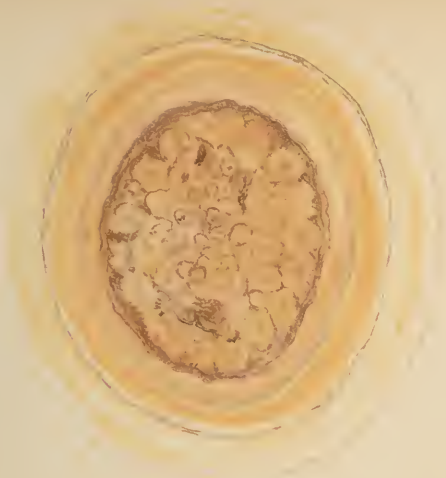
CYSTINE OR CYSTIC-OXIDE CALCULUS.—This form is almost sufficiently uncommon to claim a place in the third group of stones, those I have designated as "excessively rare." Arnaldo Cantani, in his essay on *Cystinuria*, etc.,¹ states that cases of cystine stone have only been reported 59 times in medical literature up to the date of his paper.

Wollaston discovered cystine in 1810, and believed it to be an especial and exclusive product of the walls of the bladder, but soon after Marcet found it in a kidney-stone, and Scherer in the liver. In 1824, Stromeyer and Prout found it in the urine where there was no calculus. Owen Rees thinks it more common in dogs than in men. Cleotta found it in the kidney of the ox. Beneke, in 1850, found only 3 cystine calculi among the 649 of Hunter's Museum. Leroy d'Étiolles, among 1100 stones, found only 6 of cystine. Ivanchich encountered 1 in 300 cases of lithotrity, and Dumreicher 4 in 105 operations. Golding-Bird found 11 among the 374 calculi in Guy's Hospital Museum. Ultzmann has 8 in his table of 545 stones, 3 of which are in his special collection of 200 stones.² Civiale, up to 1851, seems to have encountered cystine only 8 times. Carter says that it forms less than 1 per cent. of the stones in the Museum of Grant College, Bombay. It is exceptionally uncommon in the United States. Buck's collection in the New York Hospital contains one of large size removed by lithotrity.

Cystine may form a calculus in the kidney or in the bladder, either constituting the exclusive constituent of the calculus, or forming the nucleus. It is encountered in connection with the mixed phosphates, uric acid, and oxalate and carbonate of lime. All observers report heredity as an active cause in its production. Cystine stones occur singly, but are often multiple. They are generally small, but have been found in the bladder weighing several ounces. They are rounded, smooth, or occasionally worm-eaten on the surface. Generally yellowish, they may be white or quite dark. On section they are smooth, pale-green, waxy-looking, not laminated. The fracture looks semi-transparent, satiny, and glistening. Golding-Bird says that the yellowish color changes to a blue-green when the stone is long kept exposed to the light.

¹ *Cystinuria, Fettsucht und Gallensteine.* Berlin, 1881. The German translation, by Seigfried Hahn, forms part of the third volume of the *Specielle Pathologie und Therapie der Stoffwechselkrankheiten.*

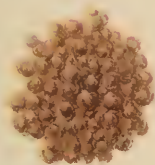
² *Die Harnconcretionen*, S. 41. 1882.



1.



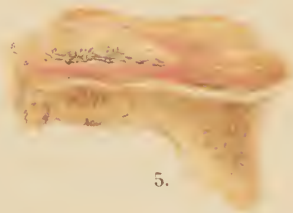
2.



3.



4.



5.



Alex. Dumas, Del.

6.



7.

H. BENCKE,

Cystine calculus is rather soft and friable, and is entirely suitable for lithotripsy.

XANTHINE, XANTHIC-OXIDE, OR URIC-OXIDE CALCULUS.—Coulson¹ gives a bibliography and description of the seven cases of xanthine stone which were known to have existed at the date of his last edition, the first discovered by Marcet in 1815, weighing eight grains (Coulson by a misprint says ounces), and the last reported in 1873, by Gaillard, removed from a boy of 13, and weighing 350 grains.

Dr. Porter, of Bridgeport, adds an eighth case, the only one recorded in America, the stone having been passed spontaneously from the kidney by a young lady. It weighed 48 grains. I have reproduced its appearance in section, in the plate which accompanies this article. (Plate XXXIII., Fig. 4.) Dr. Porter's remarks upon the case are full of interest. They appeared in the "New England Medical Monthly," for May, 1882.

Utzmann, among thousands of stones examined, never encountered xanthine, and seems rather to doubt its existence. These stones are generally small, and resemble those of uric acid. They vary from a light to a reddish-brown, are smooth and polished externally, laminated on section, but without radiate structure, assume a waxy look when rubbed, and about equal uric-acid stones in hardness. They are generally single. They have been passed spontaneously and obtained by the aid of lithotomy—but no specimen, as far as reported, has been crushed with a lithotrite. They are suitable for removal by this method.

FIBRINOUS AND BLOOD CALCULUS.—Marcet was the first to describe this very rare form of calculus. His specimens were quite small, and were passed spontaneously by a gentleman of 50. Roberts encountered a similar calculus voided by a man of 35. Prout has seen and described several. Scott Alison (quoted by Beale) found several in the kidney, one as large as a horse-bean. They have been described as whitish-gray, amber-colored, dark reddish-brown, and black. They are usually small. Roberts has one as large as a walnut, taken from the bladder of a sheep. They are generally rough, and either hard, brittle, friable, with a fracture which has been described as rusty, dull, like baked clay, or of waxy consistence, or showing fibrous texture upon fracture. They are more often multiple than single. Prout believes that they are composed of fibrin, and all agree that their occurrence is liable to be associated with previous renal hæmaturia. In a neutral saline solution of one of these concretions Owen Rees found the remains of blood-corpuscles.

UROSTEALITH; FATTY OR SAPONACEOUS CALCULUS.—This material is known to have formed calculous concretions in only four instances. Two vesical calculi, from the same individual, composed of a central saponaceous substance surrounded by a thick coating of phosphates, are now in the Museum of the Royal College of Surgeons, London. They belong to Hunter's collection, and are described in the catalogue of 1842. The presence of the earthy soap forming the centre of the calculus is ascribed in the catalogue to the fact that soapsuds had been used to wash out the patient's bladder, and it is suggested that the fatty acids, combining with the earthy bases of the urine, had formed a nucleus of "earthy soap," which in its turn had become surrounded with phosphates. Heller² described some similar masses in 1845, which, as small pisiform bodies, passed from a young man of 24. W. Moore,³ of Dublin, in

¹ Op. cit., p. 328.

² Harnconcretionen, S. 146.

³ Dub. Quart. Journ. of Med. Sci., vol. xvii. p. 473.

1853, observed two small calculi of saponaceous nature, and subsequently two large ones were taken after death from the same patient; and Vidau¹ has added another, in which the stone was as large as a bean, to the cases already known. Ultzmann,² finding no urostealith among the thousands of stones which he has examined, concludes that this substance is a foreign matter which has been introduced from without, and therefore that it is not a true calculus. Thus it appears that urostealith has only been encountered in four patients. It consists of a yellowish or brownish material, which dries into a waxy-looking mass. It seems always to be associated with a deposit of earthy phosphates, both interstitially and often as a distinct, external layer.

INDIGO CALCULUS.—Ord³ has described the specimen of indigo calculus which he showed to the London Pathological Society, March 5, 1878. Dr. Bloxam removed it after death from the right kidney of a patient, the other kidney being sarcomatous and containing an alkaline calculus. The indigo specimen was of a dark-brownish color in part, in part blue-black. It made a blue mark upon paper. It was about an inch in circumference, and weighed 40 grains. This is the only calculus of this sort thus far recorded. Ord expressed his belief to the Pathological Society that, as the ureter of the left kidney was occluded by a sarcomatous mass, some material produced by the disease in that kidney had been absorbed and excreted as indigo by the other.

Ultzmann⁴ has never encountered a calculus formed of indigo, but considers this substance not uncommon in connection with other deposits (uric acid and oxalate of lime). He possesses a uric-acid stone covered with a layer of indigo as thick as paper, and gives a beautiful photograph (Plate 7) of a microscopic section of stone, showing a number of blue crystals of indigo shut in within a mass of colorless oxalate of lime.

CHEMICAL ANALYSIS OF STONE.

To examine a stone thoroughly it must be sawed through its nucleus, and the latter, with portions of the various concentric layers, separately tested. The best plan which I have found for conducting this examination methodically, is that laid down by Loebisch,⁵ and, with certain modifications, I have followed it. The dust collected from the sawing of the stone may be first roughly examined to obtain general information. In burning some of this in a Bunsen flame, further investigations may be largely directed by noticing whether the powder burns totally away or leaves a residue, whether the flame possesses color, or the smoke odor, and whether the powder crackles in burning (oxalate of lime).

A minute fragment, to be tested, is pulverized and held at a red heat upon a bit of platinum-foil over a spirit lamp or Bunsen burner:—

A. It is entirely consumed, except a trace: the fragment is composed of organic matter; that is, uric acid, urate of ammonium, cystine, xanthine, fibrine, urostealith, or indigo.

B. It is not very sensibly reduced in bulk by heat: the fragment is composed of inorganic matter—lime, potassium, sodium, or magnesium, in the form of urate, carbonate, oxalate, or phosphate.

¹ Journ. de Pharm. et de Chim. ; and Loebisch, *Anleitung zur Harn-analyse*, zweite Aufl. S. 418. 1881.

² Op. cit., S. 5.

⁴ Op. cit.

³ Op. cit., p. 144.

⁵ Op. cit., S. 415.

A. ORGANIC CONSTITUENTS.—I. Dissolve a little of the powder with dilute nitric acid in a thin porcelain dish, dry it over a spirit lamp, and allow it to cool. Touch the yellowish-red sediment with a glass rod carrying a drop of liquor ammoniæ. A beautiful purple-red (murexid) reaction shows *uric acid*. This reaction is the same for uric acid and the urate of ammonium. To distinguish between them, boil some of the powdered stone in water. The urate is dissolved, the uric acid very slightly. The clear hot water decanted, and allowed to cool, deposits the urate. Some of this dust is collected and boiled with liquor potassæ. The fumes of ammonia are given off, recognized by the peculiar odor; yellow turmeric paper turns brown in the vapor; a rod moistened in acetic acid becomes surrounded with white fumes. These positive tests indicate *urate of ammonium*; their failure shows uric acid alone.

II. The murexid test fails. Dissolve a portion of the powder in dilute nitric acid and dry slowly with the spirit lamp; a lemon-yellow deposit is left, which shows no change with ammonia, but becomes reddish-yellow on adding a drop of liquor potassæ. This reaction shows *xanthine*.

III. The burning powder on the platinum-foil gives off a disagreeable sulphurous odor. The powder dissolves in a solution of ammonia. Acids re-precipitate it. The alkaline solution, allowed to evaporate, deposits the flat hexagonal crystals of *cystine*.

IV. The burning powder smells like burning horn. Water, alcohol, and ether fail to dissolve the powder. Liquor ammoniæ or liquor potassæ dissolves it, and from such a solution acids re-precipitate it. It swells up in acetic acid, and promptly dissolves in boiling nitric acid. These tests indicate *fibrine*.

V. The powder melts on the foil, then swells up and gives off a strong odor, recalling that of a mixture of shellac and benzoin. Ether dissolves it, and evaporating leaves an amorphous deposit, which, being heated, assumes a violet color. Vidau's urostealith calculus gave a negative result to this test. The powder dissolves into a soapy solution in warm, caustic alkalies. It dissolves with slight effervescence in nitric acid, precipitates on evaporation without change of color, and the deposit becomes dark-yellow if touched with an alkali. These tests indicate *urostealith*.

VI. The powder of Ord's *indigo* stone, on heating in a test-tube, developed purple-red fumes, which deposited dark-blue crystals on a cool surface. The crystals were characteristic, long hexagonal plates with pointed ends. The odor was sooty, like that of indigo. Strong sulphuric acid dissolved the powder first into a brownish, and then into a muddy-blue solution, which, after dilution with water and filtration, yielded a clear blue fluid. The spectrum gave the indigo line in the yellow. Besides indigo, the stone contained phosphate of lime and a trace of blood.

B. INORGANIC CONSTITUENTS.—When a considerable residue is left after burning the powdered fragment upon a piece of platinum-foil, the stone is composed either almost entirely of inorganic ingredients, or of organic salts, the earthy inorganic bases of which are not consumed by fire: such as the urates of potassium, sodium, lime, or magnesium; the oxalate, carbonate, or phosphate of lime; the ammonio-magnesian phosphate.

I. The murexid test applied to the powder shows uric acid, but the residue left on heating proves the existence of an earthy base; it is soda, potassa, lime, or magnesia. The urates generally exist in small quantity along with other ingredients; they do not alone form stone. The powder is boiled in distilled water and filtered while hot. The filtrate is evaporated and the residue brought to a red-heat. If a portion of the ash held in a Bunsen flame burns yellow, sodium is present; if violet, potassium.

Magnesia and lime exist (if at all) in the precipitate of the boiling water, after moderate heating, as carbonates. A portion of the powder is dissolved in dilute hydrochloric acid, made neutral with ammonia, and the precipitate dissolved with acetic acid; on adding oxalate of ammonium a white crystalline precipitate is thrown down (oxalate of lime). This test shows *lime*. After filtering out this precipitate the filtrate is treated with phosphate of sodium, and *magnesium* shows itself under the microscope as a precipitate of crystals of triple phosphate.

II. The murexid test fails. The powder consists of oxalate of lime; of carbonate of lime or magnesium; of triple phosphate, of secondary (neutral) phosphate of lime, or of tertiary (basic) phosphate of lime.

Oxalate of Lime.—The powder of this substance crackles under the blow-pipe, red heat blackens it, further red heat whitens it, and it becomes carbonate of lime, which now dissolves in dilute acids with effervescence. White heat reduces the powder to caustic lime, which no longer dissolves in dilute acids with effervescence, but turns moistened yellow-turmeric paper brown. Furthermore, powdered oxalate of lime, before being heated, is not influenced by acetic acid, but dissolves, without effervescence, in mineral acids, and is precipitated from such solutions by ammonia.

To distinguish between the other substances mentioned above, put some of the powder into hydrochloric acid. It dissolves: (a) with effervescence, (b) without effervescence:—

(a) *Carbonate of Lime or Carbonate of Magnesium:*—

Carbonate of Lime.—The powder blackens under moderate heat; whitens under intense heat into caustic lime, which, when moistened with water, turns yellow-turmeric paper brown. The powder, also, without previous heating, effervesces freely in dilute acids.

Carbonate of Magnesium.—Dissolve the powder in dilute hydrochloric acid, neutralize the solution with ammonia, and dissolve the precipitate with acetic acid; add phosphate of sodium and ammonium, and the magnesia will precipitate as crystalline ammonio-magnesian phosphate in the shape of little stars or oblique crosses, the form of the crystals being due to the rapidity of the crystallization.

(b) *Oxalate of Lime or Phosphates:*—

Dissolves without effervescence. The powder is brought to a red heat and again tested with hydrochloric acid.	It dissolves with effervescence	. . . oxalate of lime.	
		Develops ammonia.	Triple phosphate.
No effervescence follows, and the blow-pipe is used.	Specimen fuses. Some of the unheated dust is treated with liquor potassæ.	Develops no ammonia.	
		Secondary (neutral) phosphate of lime.	
	Specimen will not fuse, and	is tertiary (basic) phosphate of lime (bone earth).	

THE PATHOLOGICAL RESULTS OF URINARY CALCULUS.

A comprehensive view of the relation which urinary calculus bears to structural alterations in the urinary passages, is obtained by simply recognizing the distinction between the two great divisions of stone, the primary and the secondary. The former are formed by the urine, often when the urinary organs are sound; the latter demand as an essential factor in their formation that the mucous membrane lining that portion of the urinary passage in which they appear, shall be in a condition of chronic catarrhal inflammation; consequently they only exist as a sequence of antecedent disease.

The primary stone, therefore, acting precisely like any other foreign body, may become the active agent of organic tissue-changes through the instrumentality of the process of traumatic inflammation, while the secondary stone is essentially little more than an excretion solidified by accident. It is indeed rather a symptom or result of previous disease than a malady; and although by its size and weight it may react upon the malady which caused it, and may become a traumatic factor increasing the intensity of that malady, yet it always continues to occupy a position second in importance to the original disease.

A knowledge of this fact is of value in prognosis. When a primary stone is removed from the urinary passages spontaneously or surgically, provided that no other stone remains and that the surgical removal has caused no serious damage, the disease is entirely cured. Not so, however, when a secondary (phosphatic) stone is removed. The patient is not well; one of his symptoms indeed has ceased, but the persistence of the cause which gave rise to that symptom (the secondary stone) may furnish the same symptoms (another stone) again. Consequently, the curative treatment of a patient practically begins after the extraction of his secondary stone, where in the case of extraction of a primary stone it virtually ends.

The only exception to this rule is the case where a secondary phosphatic crust forms about a primary nucleus, the latter having alone served as the efficient cause for the catarrhal condition in the presence of which the phosphatic deposit occurred. Here, the foreign body being removed, the chronic inflammation which it occasioned may and often does spontaneously subside.

In the kidney, a calculous infarction may lead to a cyst, but it rarely does so. A stone retained in the pelvis of a kidney may block the ureter and occasion acute congestion, suppression, uræmia—if the other kidney be diseased—and death. It may occasion hydronephrosis. It may grow enormously, distend the pelvis of the kidney, and cause atrophy of the secreting substance. It may give rise to pyelitis and catarrhal changes in the mucous membrane of the pelvis of the kidney, going on to calculous pyelitis, pyelonephritis, pyelo-nephrosis, or perinephric abscess.

At any point along the ureter a stone may be arrested in its passage, and partly or wholly occlude the tube. In such a case, in addition to the results of occlusion at the renal orifice of the ureter, the tube itself becomes dilated above the point of obstruction, ulceration of the ureter at the point pressed upon may occur, granulations arise, and hæmaturia with blood-casts of the ureter follow.

In the bladder, at first subacute and then chronic cystitis is caused by primary stone, leading ultimately to chronic vesical catarrh with secondary incrustation of the stone by phosphates. The chronic catarrh is marked by acute exacerbations, and may lead to extension of inflammation to the kidneys, and to all the sequences of a chronic cystitis.

In the urethra, a stone may lodge in the prostatic sinus, or behind any point of physiological or pathological (stricture) narrowing of the canal. There it may grow to a large size and cause catarrhal changes in that portion of the mucous membrane upon which it presses, and in the distended urethra behind it. Therefore its accretions in the end are phosphatic, whatever its primary structure may have been.

The foregoing remarks apply to calculi belonging to the primary group. All calculi forming outside of the urinary tract—sub-preputial, scrotal, perineal, in connection with abscesses and fistulæ communicating with the urinary tract—are secondary, phosphatic, and symptomatic of urinary contact with the products of chronic inflammation.

When such concretions, wherever situated, within or without the urinary

channels, attain a certain size, they act locally as irritating foreign bodies, and increase the grade of the pre-existing inflammatory symptoms, together with the intensity of the subjective and functional phenomena to which these inflammatory symptoms give rise.

STONE IN THE KIDNEY.

All forms of urinary calculus are found in the kidney. The only indigo calculus on record was removed, after death, from the kidney. Urostealth has not yet been detected in the kidney after death, but of the four cases on record (Hunter's Museum, Heller, Moore, Vidau), in the second, Heller's, the patient complained of pain in the region of the right kidney, and passed all his small calculi by the urethra. This proof is circumstantial, but it is reasonably strong.

Secondary stone deposits occur in the kidney, but only as a sequence of pre-existing stone formation, or as an epiphenomenon in pyelitis, pyelonephritis, tubercle, cancer, etc., of that organ.

Renal nuclei usually pass on into the bladder. Those which do not escape from the kidney increase in size. They remain smooth and oval while small, and may continue in this condition while they grow, unless the pelvis of the kidney passes into a condition of chronic inflammation. In this case, alkaline deposit forms either spontaneously or upon the nucleus already at hand, and such secondary stones are liable to attain large size and to assume a branched form, extending into the calices and down into the mouth of the ureter. They often still remain oval, even after becoming phosphatic. A branching kidney stone, however, is not necessarily phosphatic. Melchior Torr  s¹ reports a large renal calculus, thoroughly branched, weighing over an ounce (37 grammes), and composed almost entirely of uric acid with a little urate of ammonium and oxalate of lime. This stone seemed to have formed as the direct result of an injury. A stone in the kidney, on the other hand, may reach enormous dimensions and retain its rounded form, not being in the least branched. Such was the large specimen obtained after death by MacGregor, and already referred to. This stone has never been chemically examined, but, although apparently covered with a layer of phosphates, it is undoubtedly an acid (primary) stone. Its weight is 51 ounces.

The symptoms of stone in the kidney (h  maturia, nephralgia, irritable bladder, reflex pains), its spontaneous escape (nephritic colic), its results (calculous pyelitis, hydronephrosis), its surgical removal (litho-nephrotomy and nephrectomy), have been considered in a previous article.² It must not be forgotten that stone may remain for years in the kidney without producing any symptom, and may be accidentally discovered after death.

STONE IN THE URETER.

There is no reason to believe that stone ever forms primarily in the ureter, and, as a rule, any calculus which fairly passes into the mouth of the ureter sooner or later works through and enters the bladder. The length of time required for this passage, in my experience, varies from a few minutes to many months. In one instance, a patient regularly had a paroxysm of nephritic colic on the

¹ Bull. de la Soc. Anat. de Paris, t. iii. p. 90. 1877.

² See page 673, *supra*.

same day of the week for several successive weeks, being without pain on the other days, until finally his stone passed. In another instance, a gentleman was treated by a homœopathic physician for what was called hernial colic (the patient wore a truss), during an entire winter. Under the use of alkaline diuretics, an acid stone which had been arrested during all this time at the vesical end of the ureter, was voided.

Both ureters may be plugged simultaneously, sometimes with single, sometimes with multiple calculi.¹ The distressing symptoms and high mortality recorded for cases of calculous anuria are well known. Reliquet² quotes Merklen's statement that out of fifty cases there were only nine cures. He proposes as a means of relief an increase of the blood pressure by a simultaneous elastic constriction of both lower extremities with elastic bands. Aided, seemingly, by this means, one of the two cases in which it was tried ended in recovery. The suggestion is due to Prof. Bouchard. The constriction may be repeated daily, and the bandages may be left in place until difficulty of breathing and general physical distress make their removal imperative.

If, instead of passing out or causing complete anuria, the calculus does not absolutely occlude the ureter, then the urine trickles along side of it, and it ultimately sets up catarrhal inflammation in the ureter, and becomes a phosphatic stone with acid nucleus. Or the calculus may form a pouch for itself, a sort of sacculation, as in a case shown by Norman Moore to the London Pathological Society.³ The specimen was removed after death. The pouch had become surrounded by a large deposit of fat, which Moore believed to be due to irritation.

Total suppression due to calculus impacted in the ureter has caused a number of deaths in persons from whom one kidney has been removed. So positively has this fact been observed that it has been brought forward as a reason why nephrectomy should not be performed. I have personal knowledge of one death from this cause.

The symptoms of impacted stone in the ureter vary. There has generally been prolonged nephritic colic, without the passage of the stone. There is always, at first, partial anuria, complete if both ureters are plugged. More or less pain is felt about the region of the kidney on the affected side. There is often a dull pain in the groin, and more or less in the testicle of the same side. There may be considerable or very little irritability of the bladder, with some pus and blood in the urine. Localized tenderness, increased by manipulation, often marks the point in the ureter at which the stone lies. This point is usually near the upper or the lower outlet of the tube.

Treatment.—When a stone is stopped in a ureter, it is to be presumed that the methods employed for the relief of renal colic have failed—such as hot baths, diluents, opiates, diuretics, electricity, external manipulation, cups to the loins. Should there be complete calculous anuria, these methods should be persisted in with renewed energy, and Reliquet's plan of simultaneous elastic compression of both lower extremities should be tried. Along with this, Reliquet recommends repeated rectal injection of small quantities of iced water. A little pilocarpin might be cautiously tried subcutaneously ($\frac{1}{12}$ — $\frac{1}{8}$ grain), to which might be added the copious use of Bethesda water or light beer. Modern surgery has further placed at our command more radical measures which should always be tried before it is too late, when a positive diagnosis can be made.

¹ Fatal case with autopsy. H. Haehner, Berlin. klin. Wochenschrift, 12 Sept. 1881, S. 531.

² Anurie calculeuse, etc., Note lue à la Soc. de Méd. de Paris, 11 Fév. 1882. (Extrait de L'Union Médicale, 3ème série, 23 et 25 Mai, 1882.)

³ Lancet, March 25, 1882, p. 482.

A brilliant innovation of modern surgery is nephrolithotomy for calculous anuria. Dr. Thelen,¹ of Cologne, has described a successful case, Bardenheuer being the operator. Czerny first suggested the performance of nephrolithotomy. H. Morris² first performed it, but not for obstruction; his case was one of kidney stone without suppression.³ In Thelen's case the patient had had left suppurative pyelitis and perinephric abscess. Through an incision made into this abscess the kidney was felt to be entirely atrophied. Suddenly, during convalescence, complete suppression came on. Bardenheuer thereupon exposed the other ureter in the flank, found in it a calculus as large as a bean, firmly impacted, liberated the calculus by a longitudinal incision, and sewed up the ureter. After temporary relief, a severe chill and high temperature caused Bardenheuer to reopen the wound, cut the ureter, and bring out its proximal end into the wound. A month afterwards the patient was doing well, urinating through the wound.

Sometimes a stone, reaching the vesical orifice of a ureter but not entirely obstructing it, will grow by phosphatic accretion, and finally find its way into the bladder by ulceration, or it may prolong itself into the bladder. Sometimes a vesical stone grows into the ureter.

PROSTATIC STONE.

Two forms of concretion may be encountered in the prostate and its sinus, the true prostatic concretion, and urinary calculus. The former will receive consideration in another article.⁴

Primary urinary calculus does not form in the prostate. An acid nucleus or fragment may lodge in the sinus, and for a time increase as an acid stone. But sometimes nuclei detained in the prostate grow by the addition of layers mainly composed of phosphate of lime—in this way coming to resemble true prostatic concretions. There are five methods by which urinary calculus may form in the prostate.

1. A nucleus from the kidney may become arrested there and grow.

Ebel⁵ relates the case of a boy who, at the age of three, commenced to suffer from urinary discomfort and occasional attacks of retention. This persisted for six years, until a bean-sized stone was removed from the prostatic sinus by a cutting operation.

2. A fragment after lithotripsy may behave in a similar manner.

3. A true prostatic concretion, reaching a certain size, may ulcerate its way into the prostatic sinus and continue to grow, a pure phosphate-of-lime prostatic calculus, as in Mastin's⁶ case. Or it may receive accretions of urinary salts and grow backward into the bladder, reaching considerable dimensions—prostatico-vesical calculus.

4. A vesical calculus may send a prolongation forward into the prostate, vesico-prostatic calculus.

5. An abscess in the prostate may leave a pouch in which urine accumulates, decomposes, and gives rise to a calculus. The same thing may happen in the fistulous tracts left by burrowing abscesses, and after lithotomy.

Stones in this region attain great size, and may ulcerate their way outwards into the scrotum, perineum, or rectum. A large phosphatic calculus

¹ Centralblatt f. Chir., 25 März, 1882, S. 185.

² Lancet, Oct. 30, 1880, p. 698.

³ Up to May 23, 1884, eight cases of pure nephrolithotomy, all told, had been performed without one death. (Lancet, May 31, 1884, p. 983.)

⁴ See article on Injuries and Diseases of the Bladder and Prostate, *infra*.

⁵ Mag. f. d. ges. Heilk., Bd. xlviii. S. 271. 1837.

⁶ Medical News, August 16, 1884, p. 175.

which presumably had been carried by the patient for fifty years, and had made a nest for itself in the perineum and prostate, was removed by Walton.¹ Its diameters were two and a half inches by one inch. Many other cases will be found included under the head of *urethral calculus*.

Symptoms.—Prostatic stones, even when very small, may give rise to much annoyance; yet the parts sometimes acquire surprising tolerance of the foreign body, and the calculus may be first revealed during an autopsy. I find two cases in which large prostatic calculi were perforated by a natural channel for the escape of urine. One of these calculi, removed by Rushton Parker,² weighed an ounce and a half. It seemed to replace the prostate, and had a central perforation. The other, observed by T. Sympson,³ had two channels widely separated from each other. It was a vesico-prostatic calculus.

The actual symptoms of prostatic stone are a varying amount of pain, weight, heat, dragging, throbbing in the perineum and rectum—possibly abscess, irritability of the bladder, retention of urine, presence of more or less pus and blood in the urine, erotic desires and a tendency to priapism—or there may be practically no symptoms at all. A searcher can generally be made to enter the bladder with ease, and diagnosis is established by the grating sound and confirmed by rectal touch.

Treatment.—If the stone is small and has recently lodged in the prostatic sinus, an effort should be made to push it back into the bladder with a large, blunt, steel sound, or by passing a hollow tube up to the stone, and rapidly injecting a large amount of warm oil through it while the urethra is kept compressed about the tube. If these means fail, an attempt may be made to crush the stone with a small urethral lithotrite, or to extract it with the long urethral forceps or a Thompson's divulsor, as recommended for urethral calculus. Failing in this, and in all cases of large stone, a perineal incision is required—in the median line for stones of moderate dimensions; lateral or bilateral incision for stones of very large size.

URETHRAL CALCULUS.

It is not probable that primary acid stone forms in the urethra. Secondary alkaline stones do originate there in ulcerated pouches, behind tight stricture, in cavities left by abscesses, and perhaps in dilated follicles with narrow mouths. Commonly, urethral stone forms upon a nucleus sent down from above, a kidney-stone, or a fragment left after lithotripsy. In young children a kidney-stone on its passage is often arrested in the fossa navicularis, or at the meatus; in older persons, in the more sensitive membranous urethra. Here it remains grasped by the muscular urethral walls, and grows by the addition, first of uric acid, and afterwards of phosphates. Ulceration may ensue and the stone find its way out spontaneously (Civiale).⁴ How long urethral stone may be carried is uncertain. In a case recorded by Block,⁵ such a stone was extracted after a sojourn of twenty-eight years. Urethral stone may be single or multiple to any extent; particularly is urethral calculus multiple when the floor of the urethra communicates with a pouch beneath. I have encountered this condition once, extracting five phosphatic stones.

The size which urethral calculus may reach, and other points connected with the subject, may be illustrated by briefly citing some curious cases. Zeissl⁶ has collected a number of these, among them Wattmann's case, that

¹ Trans. Path. Soc. Lond., vol. xiii. p. 143. 1862.

² Brit. Med. Journ., vol. i. p. 85. 1878.

³ Ibid., vol. i. p. 413. 1878.

⁴ Op. cit., p. 607.

⁵ Acta Acad. Nat. Curios., tom. viii. p. 441. Norimberge, 1748.

⁶ Ueber die Steine in der Harnroehre des Mannes. Stuttgart, 1883.

of a man of 80, who passed in all 300 stones by the urethra. Pulido's scrotal stone, weighing $23\frac{1}{2}$ ounces, taken out by incision through the scrotum; the patient recovered with fistula. Rathelot's urethral stone of 60 grammes, removed by incision, fistula remaining. Gräfe's scrotal stone of 26 ounces, which escaped spontaneously while the patient was making a straining effort. Ulecia's case of an 80-gramme stone removed by incision. Civiale's case of the old man whose bladder and urethra were so full of stones that no one had the patience to count them. Voillemier's stone of 2 ounces 6 drachms, which filled the entire urethra from the meatus to the membranous portion, being composed of several segments. Camper's 5-ounce stone cut from the membranous urethra. Maigrot's stone of nearly 8 ounces, cut from the membranous and prostatic urethra by the bilateral operation, with fatal result. Da Luz's 20 $\frac{1}{2}$ -ounce scrotal stone. Heath's cystine stones, and many others of interest.

Vanzetti¹ tells of a Russian, who at the age of one year passed a kidney-stone which became arrested in the fossa navicularis, and ulcerated its way through the floor of the urethra. In its sac, which did not communicate with the preputial cavity, it grew for eighteen years, and when removed consisted of one large and many small calculi, weighing collectively 224 grammes, more than seven ounces.

Bellamy² removed two phosphatic calculi weighing one ounce, from a sac beneath the urethra just in front of the scrotum in a man of forty. The sac was incised and a small orifice of communication was found between it and the urethra. The patient recovered without fistula. Walton³ refers to another such sub-urethral sac connected with the spongy portion of the canal. It contained 146 calculi, and is now in the Museum of St. Bartholomew's Hospital. Kerr⁴ gives another case, where a similar sac was found to contain 291 calculi, four of which were as large as pigeon's eggs. This patient was 21 years old, and had carried the sac from birth.

Symptoms.—The symptoms of urethral calculus vary with the position of the stone. A very small stone in the membranous urethra may cause partial or entire retention of urine by exciting permanent spasm of the "cut-off" muscles. I have recorded a case⁵ where retention, over-distention, and overflow ensued from this cause. Impacted calculus at the meatus may also (but rarely) cause retention, and calculus impacted in a tight stricture may do the same. Otherwise urethral stone causes irritation, gleet, irritability of the bladder, tendency to erection, pain on erection, general inflammatory phenomena, etc., more or less intense, according to the position and size of the stone and the general condition of the patient. In front of the peno-scrotal angle, or at any part of the canal, if the foreign body be large enough, it may be felt from the outside.

Diagnosis, in doubtful cases, is made by touching the stone with a probe or sound introduced through the meatus.

Treatment.—A urethral calculus, when small and round, may be washed out of the canal by causing the patient to drink freely of mild, diluted drinks, or even of gin or beer. The patient should be instructed to hold his urine as long as possible; then he should receive a small, subcutaneous dose of morphine or a dose of chloral, take a very hot bath, pass his water freely in the bath, and, when the stream is under full headway, arrest it suddenly by compressing the urethra, without relaxing the effort at urination, and then immediately allow the stream to continue its flow. This sudden distention of the urethra will often dislodge a small stone. If such a small stone lies behind

¹ Bull. de la Soc. Anat. de Par., t. xix. p. 16. 1844.

² Trans. Clin. Soc. Lond., vol. xi. p. 22. 1878.

³ Trans. Path. Soc. Lond., vol. xiii. p. 43. 1862.

⁴ New York Med. Journal, vol. xv. p. 283. 1872.

⁵ Med. Record, March 6, 1875.

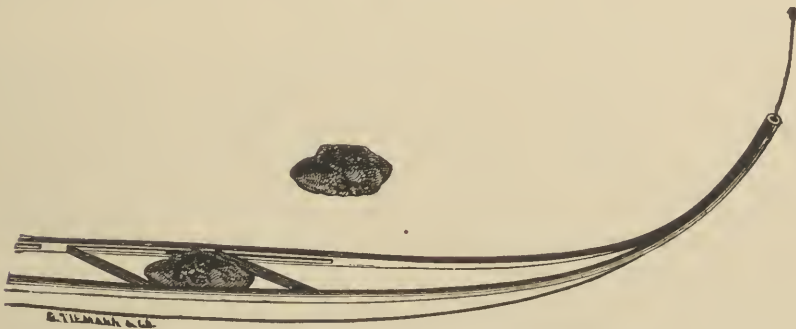
the bulbo-membranous junction, it is better to push it back with a large, blunt, steel sound into the bladder, whence it may be afterwards washed out through a tube or crushed. Or it might be washed back into the bladder by injecting warm oil through an open tube passed down to it. If it can be felt in or anterior to the perineum, March's¹ expedient may be employed. This consists in passing a very large blunt steel sound up to the obstruction, and then, by external manipulations upon the calculus alone, to push out at the same time both it and the sound; the latter, of course, maintaining an open urethra as it goes.

This is very similar to the expedient first suggested by Averill, that a large sound should be carried down to the stone, and, while the patient made a continued effort to urinate, the sound should be withdrawn that the stone might more easily escape through the distended urethra.

When the stone is large, rough, angular, or lodged behind a constriction, these means do not suffice. It must then be extracted with forceps, or the urethra must be incised. I have not found the urethral lithotrite of service, but believe that it might be available in a case of prostatic stone. Leroy d'Etiolles's scoop, the crocodile forceps, and the long urethral forceps, in my hands uniformly scrape, pinch, or tear the urethra, and I no longer use them.

The best instrument in my experience for extracting foreign bodies from the urethra has been Thompson's divulsor, designed for splitting strictures. My first success² was upon a physician in whose membranous urethra a rough oxalate-of-lime calculus had been lodged for two months, causing repeated retention of urine, vesical distention, and overflow. The accompanying figure shows the stone in position as it was caught and extracted. The diam-

Fig. 1214.



Extraction of urethral calculus with Thompson's divulsor.

eters of this calculus were $\frac{1}{2}$ and $\frac{5}{16}$ inch. The whalebone guide slipped easily past it, and the tunnelled divulsor followed without difficulty. The blades were separated, and, on being approximated, caught the stone and extracted it with ease. I found afterwards that this expedient had been previously resorted to with success by Dr. Westmoreland,³ of Georgia. Subsequently I removed⁴ a pin from the deep urethra of the male with the same instrument, and without any difficulty. A divulsor with one cross-bar is preferable to those which have two.

¹ Trans. New York State Med. Soc., p. 71. 1867.

² New York Med. Record, March 6, 1875.

³ Atlanta Med. and Surg. Journ., Oct. 1874, p. 415.

⁴ New York Med. Record, May 1, 1875.

In trying to remove an angular fragment with any instrument, there would be great risk of tearing the urethra, and in any such case, or where the stone is quite large, a single, clean, free, longitudinal incision of the urethra at the site of the stone is probably better than other methods.

Such incisions heal rapidly if kept clean, and never, in my experience, yield fistulæ. All that it is necessary to do, even when the cut is extensive, is, if the urine be ammoniacal, to inject a little warm water through the urethra, letting it pass out by the fistula after each act of urination, when the healing process is approaching its termination. If the urine be normal, no such precaution is usually necessary. All encysted urethral stones require treatment by external incision, and the wound must be handled afterward according to general surgical principles. There is a liability for fistula to remain in these cases when the urethra is much thickened and chronically inflamed at the position occupied by the stone.

PREPUTIAL CALCULI.

Sub-preputial calculi are common in China. In Europe and America they are rare. Among 15,000 patients examined by Albers,¹ in 1835, only one case of preputial stone was found; while Lewin,² among 35,000 hospital patients examined during fifteen years, found only three cases. Kerr,³ on the other hand, declares that the affection is not uncommon in China, and gives a table of 18 personal cases.

This malady is encountered at all periods of life. Uncleanliness and a tight prepuce are prime factors in its production.

The efficient causes are three: (1) calcification of smegma; (2) retention of a small renal or vesical stone passed from above; (3) ammoniacal degeneration of urine retained within a tight prepuce.

(1) *Calcified Smegma*.—Every one who has removed from a child a tight, adherent prepuce, has noticed the little white rolls of smegma imprisoned behind the corona glandis. If these masses are retained long enough they acquire considerable size, cause the prepuce to inflame, and, finally, calcify more or less completely. They may subsequently act as nuclei for the precipitation of urinary salts out of urine retained in the preputial cavity. Salkowsky and Zahn have examined these concretions, and have found fat, fatty acids, lime salts (but no uric or phosphoric acid), epithelium, cholesterine, and bacteria.

(2) *Retention of a Small Urinary Stone*.—This occasionally happens, but is exceptionally rare, because any stone that can pass the meatus urinarius can, as a rule, also escape at the preputial orifice. It may lodge, however, and then becomes a nucleus for further calculous deposit.

(3) Most common among the causes of preputial stone is *tightness of the preputial orifice* and consequent retention within its cavity of a few drops of urine. This residuum decomposes, and deposits triple-phosphate crystals and earthy-phosphatic dust in a magma of mucous colloid, and deposits continue from new portions of urine until stones of considerable size may be formed.

The composition of preputial calculi is ordinarily a little urate of ammonium and much triple and earthy phosphate, with a great deal of mucus. They are generally multiple. The least number found in any of Kerr's cases was two; the greatest number, 116. They are usually faceted and queerly fitted

¹ Journ. der Chir. und Augenheilkunde, Bd. xxiv. S. 247. 1836.

² Ueber Präputialsteine, Berl. klin. Wochenschr., Bd. xvi. S. 177 und 197. 1879.

³ New York Med. Journal, xv. p. 283.

into each other and about the glans penis, being often laminated and concavo-convex in shape, sometimes capping the glans penis, and perforated to allow the passage of urine.

In size these calculi vary from a minute cluster of crystals up to concretions as large as an egg. In one of Kerr's cases they weighed one ounce two drachms and two scruples, and Bardeleben¹ refers to a stone reported by Duméril, which weighed two hundred and fifty-five grammes—about eight ounces. This sounds improbable. No reference is given, and I have been unable to find the original report. Civiale² speaks of a young man of twenty, with phimosis, who, after practising coitus for the first time, experienced pain and a purulent discharge. Civiale removed five stones as large as prunes. These had been felt by the patient, but he had supposed that it was perfectly natural to have them.

The results of subpreputial stone are disturbance in the function of the penis, atrophy of the glans, and more or less ulceration and inflammation within the preputial cavity.

The symptoms are hard lumps felt beneath the prepuce, more or less pain, purulent discharge, interference with urination and coitus, involuntary pollutions—in some cases, finally, impotence.

The treatment consists in ablation of the prepuce with the calculi.

UMBILICAL CALCULI.

Scattered instances are encountered of cases in which a calculus has been extracted or spontaneously voided from the umbilical region, a calculus presumably formed in a pervious urachus, or a kidney-stone that has found its way out through this strange channel. Umbilical stones are generally phosphatic.

Among the classical cases may be mentioned that of Boyer, who took twelve calculi out of a patulous urachus in a man of twenty-six, and that of Thomas Paget,³ of Leicester, who removed, from the patulous urachus of a patient, a ring-like, phosphatic concretion with a hair for a nucleus. Another case, in a man of forty, is reported by H. C. Stewart.⁴ The calculus is called phosphatic, and described as being as large as a hazel-nut. H. D. Vosburg⁵ reports the case of a mechanic of fifty, from whose umbilical region a phosphatic stone as large as a hickory-nut was voided. A similar stone had been passed by the man in the same way twenty years previously. These records, and those of J. Dixon⁶ and several others, generally make no mention of urinary symptoms. The complaint is of local discomfort, the inflammatory swelling is obvious, and the foreign body is palpable. The latter seems fully capable of discharging itself under poulticing, and recovery follows.

URINARY CALCULI OUTSIDE OF THE URINARY TRACT.

Wherever urine may trickle through a fistulous track, secondary urinary calculus may form, composed of triple and earthy phosphates, mixed often with some urate of ammonium. Stones also, starting within the urethra, may by ulceration get into the scrotum, perineum, or elsewhere, and increase enormously as outside stones. Civiale⁷ speaks of a stone taken from the

¹ Lehrbuch der Chirurgie, 7te Ausgabe, Bd. iv. S. 354.

² Op. cit., p. 560.

³ Med.-Chir. Trans., vol. xxxiii. p. 294. (See Fig. 1202, page 568, *supra*.)

⁴ Lancet, vol. ii. p. 294. 1849.

⁵ Lond. Med. Repository, N. S., vol. i. p. 291. 1824.

⁶ Ibid.

⁷ Op. cit., p. 589.

scrotum of a boy of eighteen, which was three inches long and one inch in circumference centrally. Lippoman¹ records the case of a man of sixty-eight, who, fifteen years previously, had had a scrotal stone, weighing one hundred and twenty grammes, removed by incision. A fistula remained. New stone formation occurred, and Lippoman took out four phosphatic calculi, weighing forty grammes, as large collectively as a goose-egg. Louis² refers to an enormous perineal stone, weighing ten and a half ounces, removed by M. de Gaigneau from a patient of fifty-eight, who had been cut for a stone at the age of eight, and was known to have carried his perineal stone more than twenty years. In the same article he quotes a most remarkable case from a dissertation by Denys de Launay, printed in 1700. Five years after lithotomy, a large stone escaped spontaneously from the perineum of the patient, and was discovered in his bed. The surgeon who was summoned, it is related, then and there, through the same opening, withdrew from the bladder a stone which weighed seventeen ounces.

Amussat³ records another case of spontaneous exit of vesical calculi in front of the scrotum. The patient was thirty-three years old, and had suffered for twenty years previously from urinary symptoms; the stones had ulcerated their way through the skin, and were pressed out by the surgeon. There were two stones fitted together, collectively one by two inches in diameter. It is narrated of this patient that, up to a short time before the spontaneous exit of the stones, he had urinated and performed the sexual act naturally. He got well without a fistula. Alex. Patterson⁴ reports a case of perineal stone following a traumatism. The patient removed an ounce with a chisel, and the rest of the stone, weighing 14½ ounces, came away spontaneously.

Vaginal calculus is a similar instance of outside stone formation. Herbert Cole⁵ describes two such calculi taken from the vagina of a child of eight, one of which had a button for a nucleus. The total weight of these mixed phosphatic stones was four ounces. The floor of the urethra had sloughed. J. G. Wilson, of Glasgow,⁶ speaks of a uterine calculus, discovered and removed during labor, and believed to have been due to vesico-uterine fistula. The secretary of the Edinburgh Obstetrical Society reports another precisely similar case in the same journal. In neither instance was the fistula seen. Old medical writings contain numerous references to uterine calculi, most of which are undoubtedly examples of calcareous tissue change.⁷ I have removed, by lithotomy, a large phosphatic calculus which had collected in the vagina of a lady who had suffered from vesico-vaginal fistula, and whose vulva had been nearly closed to create a reservoir for the urine.

The cavities of abscesses in the pelvis, perineum, and thighs, which communicate with the bladder, often contain more or less phosphatic calculous material.

Thus it will be seen that after lithotomy leaving a fistula, in cases of abscess or wound communicating with the bladder, or in connection with a stone ulcerating its way out, phosphatic calculous material is quite sure to precipitate in any situation outside of the bladder.

The *symptoms* of such stones vary with their position and size.

The *treatment* is removal and operative closure of the vesical end of the fistula, when practicable.

¹ Wratschebuyja Wedomosti, No. 454, 1881; and Centralblatt f. Chir., 23 April, 1881.

² Mém. de l'Acad. Roy. de Chir., t. iii. p. 332.

³ Rev. de Thérap. Méd.-Chir., p. 372. Paris, 1869.

⁴ Glasgow Med. Journ., June, 1884, p. 409.

⁵ Lond. Med. Reposit., vol. viii. p. 109. 1817.

⁶ Edinb. Med. Journal, vol. viii. p. 92. 1826.

⁷ An interesting article by Louis, with ample references to previously reported cases in this line, is found in the Mém. de l'Acad. Roy. de Chir., t. ii. pp. 130-150. Paris, 1753.

STONE IN THE BLADDER.

The frequency of stone in the bladder, the serious discomfort which it occasions, and the brilliancy and success of the various operations for its removal, have made it a subject of great interest to surgeons. The ingenuity of man has taxed itself to devise cunning instruments, monuments of mechanical skill, and to plan out bold operations for the relief of this painful disorder, and probably no field in medicine or surgery has furnished a fairer harvest for the quack.

POSITION OF STONE IN THE BLADDER.—A small calculus in a healthy bladder lies at the neck of the organ when the latter is empty, and, during distention, rests upon that portion of the bladder which is most dependent. The stone is freely movable, and consequently shifts its position with the varying posture of the patient. This change of position helps to explain the symptoms, relief during repose, aggravation by exercise when the foreign body is rubbed against the bladder's most sensitive portion, its neck.

When the prostate is much enlarged, the stone habitually rests in the *bass-fond* behind it, and does not, in any ordinary position of the patient, ever touch the neck of the bladder except when the bladder is empty. In this way an old man may carry a small stone without suffering any of the customary symptoms. Such stones are frequently first detected by accident. When the bladder is sacculated, a stone may lodge in one of the pockets. Calculi, indeed, may form in these pockets and never leave them, thus becoming encysted stones, or the stone may lie partly within and partly without a pouch. A bilobed bladder may contain a stone¹ which may occupy the cavities alternately. A vesical tumor may fix the position of a stone. A calculus may form and remain in an abscess-cavity in the walls of the bladder. A stone may be adherent to an ulcerated surface, or to a tumor, or may be fixed by partial impaction in the orifice of a ureter, or of the urethra.

A stone may sometimes be retained by contraction of certain parts of the bladder-walls about it, thus being held behind the pubis or at the fundus, there being no true adhesion.

Encysted Calculus.—This variety generally commences as a sacculated stone, which, growing by concentric accretions, distends its pouch to its utmost capacity, the stone becoming larger than the mouth of the pouch. Such a stone may become hour-glass-shaped, for, after it has completely filled the pouch, it grows by deposit upon the exposed part presenting toward the bladder, and thus growing becomes in shape like a dumb-bell with a narrow neck. Such stones cause obscure symptoms and are often difficult to remove.

When a stone in the bladder is very large, its position does not change. It becomes oval, and perhaps sends prolongations into the ureters and urethra; the thickened and inflamed wall of the bladder embraces it upon all sides and the urine trickles away, there being perhaps true incontinence. Such stones may be easily felt by the finger in the rectum.

Adherent Calculus.—The possibility of the adhesion of a calculus to the vesical mucous membrane has been denied. It is certainly not as common as might be inferred from reading reports of cases of lithotomy, for it is not very exceptional to read that the stone adhered to the bladder and was extracted with considerable difficulty.

Undoubtedly this hypothesis is frequently suggested by difficulty in extracting a stone, especially if a rough side of the stone happens to come out cov-

¹ Case of Scarenzio, quoted by Gross (op. cit., p. 190).

ered with a blood clot. But adhesion does occur in two ways: (1) crystalline deposits form upon an eroded surface and are entangled in long granulations; and (2) the pressure of a rough stone may so irritate the mucous membrane that granulations form and entangle themselves among the irregularities of the stone.

T. G. Morton¹ reports an operation for removal of a phosphatic calculus of one hundred and sixty-five grains, which was firmly attached by a long pedicle to the top of the bladder. All doubt about the adhesion of stones has been removed by evidence furnished at autopsies—such as the following:—

A woman² of 50 died at the Middlesex Hospital, England, of uterine and ovarian cancer, having no symptoms of stone. A vesical calculus was found after death, a “flat scale or lamina about half an inch in diameter, situated at the base of the bladder about an inch from the opening of the urethra.” It reposed upon an ulcerated area, and minute shreds of tissue could be seen passing into the concretion which was composed mainly of phosphate of lime and crystals of oxalate of lime. Mr. Nunn³ reports an example of adherent stone, as large as a nutmeg, composed exteriorly of uric acid and phosphates, and found in a dead-house case. The stone was attached just behind the prostate. Finally, another post-mortem case is related by F. Powell.⁴ It occurred at the Necker Hospital, Paris, and Civiale exhibited the specimen to his class. The stone was phosphatic, projected three-quarters of an inch into the bladder, and had formed upon an ulcer at the base of the bladder, being firmly attached to the muscular coat.

I have encountered adherent stone only once, and this was a thin layer mixed with granulations on the back wall of a bladder in a patient whom I cut by the median operation, and from whom I extracted a small phosphatic stone. To remove the adherent laminated stone, I was obliged to use considerable force, and to scrape the mucous membrane bare, removing both granulations and débris of stone. The patient made a good recovery under injections acidulated with dilute nitric acid. When a stone is adherent, the symptoms it occasions are usually obscure and generally more like the symptoms of severe chronic cystitis than like the classical symptoms of stone.

SYMPTOMS OF URINARY CALCULUS IN THE BLADDER.—There is no symptom, no set of symptoms, absolutely and invariably pathognomonic of the existence of stone in the bladder, except the physical sign furnished by touching it directly or with an instrument. All so-called symptoms may be present without stone. On the other hand, there is no ordinary symptom of calculus which may not be absent in a given case, and perhaps all of them may fail, and the stone elude even a skilled searcher.

A certain grouping of symptoms, however, is very suggestive of the presence of stone. These symptoms are:—

1. Frequency of urination, greater by day than by night, aggravated by exercise, especially by jolting, and sometimes amounting to incontinence in children, or even in an old patient with a large stone, or when a portion of the stone grows into the urethral orifice.

2. Hæmaturia, especially after exercise.

3. Sudden stoppage of the full stream of urine, attended by pain and a desire to strain.

4. Pain, sometimes referred to the rectum or perineum, more often to the meatus urinarius, or, especially in the adult, to a point on the under surface of the urethra, about three-quarters of an inch from the meatus.

¹ Penna. Hosp. Reports, p. 49. 1869.

² Van der Byl, Trans. Path. Soc. Lond., vol. ix. p. 296. 1857-1858.

³ Med. Times and Gaz., vol. ix. p. 579. 1854.

⁴ Ibid., vol. ix. p. 528. 1854.

5. A tendency to pull at the end of the penis, especially in children and young adults, a habit which leads to permanent elongation of the prepuce in the former, and to masturbation in the latter.

6. Pus or stringy mucus in the urine.

7. Intense straining with severe pain during and after each act of urination, a pain often of agonizing intensity. These paroxysms exhaust the patient's strength, and during them he resembles a woman in the third stage of labor. In children, prolapse of the rectum is a common result of this straining, with fecal evacuations during the paroxysms, while adults complain of hemorrhoids, pass blood by the rectum, and during the paroxysms suffer from unavoidable escape of intestinal flatus, and often of feces. The paroxysms vary in intensity and duration.

8. Reflex pains in the back, testicle, thigh, and not uncommonly in the sole of the foot (pododynia).

9. Priapism with, or more often without, sexual desire.

10. All the symptoms of chronic catarrh of the bladder, especially in the case of secondary (phosphatic) calculi.

Should several of these symptoms coincide in a given case, a suspicion of calculus is justified, but they may all occur when there is no stone, and stone may be in the bladder without furnishing any of these symptoms, while nothing is more common in old men than for the presence of stone to be masked by the ordinary symptoms of catarrhal cystitis accompanying enlarged prostate.

Young people, as a rule, suffer more from stone than old ones. Their symptoms are generally more obvious, and an error of diagnosis from lack of symptoms is not likely to occur. With adults this is not always the case.

I extracted by lithotrity a calculus larger than a pea from a gentleman who had passed it into his bladder during an attack of nephritic colic two months previously, and had not been inconvenienced by it in any way until a few days before applying to me. In many instances I have removed primary smooth stones of considerable size where the patients have been positive that their symptoms only dated back a year or more, while a careful cross-questioning has been able to place the date of origin of the stone a number of years before, at some well-remembered attack of marked nephritic colic not followed by an escape of stone from the urethra.

In one case a gentleman applied to me for relief from slight irritability of the bladder, of recent occurrence. His urine was heavy, contained crystals of uric acid, and a few pus-cells. An alkaline diluent was ordered, and he was relieved and believed himself well. After many months frequency of urination recurred, and then a search revealed the fact that the bladder was full of small calculi. I washed out six of these, as large as peas, through a Bigelow tube in my office, and felt many more larger ones rattling against it. This manœuvre so relieved the patient that he pronounced himself well, and declined to submit to further instrumentation, and this in spite of my strongest assertions that the bladder still contained stone. He simply declined to believe it, although I had felt them and made him hear the sound.

A youth of about 18, with a congenitally long, tight prepuce, intensely nervous, and a masturbator, applied to me, complaining that he passed water too often, and was obliged to pull upon the penis and scratch the under surface of the urethra and the perineum during and after the act of urination, and to practise masturbation. He had no pain, no tenesmus, nor other symptom. The urine was not perfectly clear, but was no more purulent than might be expected in one who habitually urinated too often. As a first and necessary step in the case, I suggested circumcision. This was done, but no improvement followed. The patient was then searched, and a stone over an inch in diameter found and removed.

No old man with prostatic hypertrophy and catarrhal disease of the bladder should be allowed to go unsearched for stone, whether he has the so-called symptoms of stone or not. In such cases there is very often no symptom present which could not be accounted for equally well by the catarrh of the bladder and the prostatic hypertrophy. But in these cases, when stone is found, its removal greatly comforts the patient, although it may not absolutely cure him. But to return to a specific consideration of the separate symptoms, any of which may be caused by stone, and the association of which is nearly pathognomonic.

1. *Frequency of Urination more marked by Day.*—This symptom is quite constant—except in the case of old men with prostatic enlargement. The latter almost uniformly causes nocturnal frequency of urination, and the presence of one or more small stones in the residual urine may not modify this symptom. Such a patient will urinate more often by night than by day, except during occasional exacerbations of the cystitis—"attacks of the stone"—when the intervals by day will probably be shorter than they are by night. The stone in these patients never touches the neck of the bladder.

This rule does not hold good when in cases of enlarged prostate there is no residual urine, nor in any case where the stone is large. Here the diurnal frequency of urination is more marked. A reason for this is not far to seek. When there is no *bas-fond* behind the prostate, the floor of the bladder is about on a level with its neck, and, when the patient is erect and moving about, the stone rolls against the neck of the bladder and irritates this sensitive part. During urination, also, the stone is driven against the vesical orifice, and the tenesmus after urination—a blind effort on the part of nature to get rid of the cause of annoyance—mercilessly grinds the stone against the most tender part of the bladder. This is especially the case in young children.

An irritation, even a cystitis, about the neck of the bladder, is in this way produced, and is mechanically aggravated by the movements of the stone during the day, while rest at night gives the tender vesical orifice a certain respite.

Considerable cystitis, even an ulcer,¹ may exist at the fundus of the bladder with no frequency of urination to announce its presence; but not so if the inflammation involves the neck of the bladder. In the latter case, urination is invariably too frequent, and especially so by day while the patient is conscious of his sensations, and more particularly if he be moving about. With an enlarged prostate, residual urine, and a *bas-fond* behind the prostate in which the stone reposes, exercise does not rub the stone, if it be small, against the neck of the bladder, and urination does not raise it high enough to touch the neck of the bladder at all; consequently the old man may continue, as is the wont of prostatic patients, to urinate too often by night, not being much annoyed by day except during the paroxysms of aggravation of the cystitis, when the inflammation spreads to the vesical neck. Then the patient has "an attack of the stone." It is obvious why in irritability of the bladder (neuralgia), ordinary cystitis complicating stricture of the urethra, acute prostatic disease, etc., urination should be more frequent by day than by night, although the patient has no stone; for in these cases the neck of the bladder is in a state of irritation, and the patient while awake is more conscious of this irritation than during sleep.

2. *Hæmaturia*, as a symptom of stone in the bladder, is traumatic in its origin. It arises from the direct mechanical injury done to the gorged vessels near the neck of the bladder by the stone, or, exceptionally, from the

¹ See T. H. Bartlett's case. *Lancet*, Feb. 5, 1876, p. 210.

intensity of the cystitis alone. Hence it is valuable as an early diagnostic sign of stone, and is generally noticed after exercise. It is rarely absent in children, frequently lacking in old men. In doubtful cases it may be recognized by the smoky tint of the urine, or even the microscope may be required. Hæmaturia is so common that it has no value as a symptom, except when combined with others.

3. *Sudden stoppage of the stream during urination* is caused by the action of the stone as a ball-valve, the urine carrying it into the vesical orifice of the urethra. Children commonly present this symptom, while old men frequently escape for the reasons given above. Conversely, the symptom occurs sometimes in cases of pedunculated prostatic tumor, and in cases of irritability and spasm of the cut-off muscles of the deep urethra, the cause of the spasm being generally reflex, and due to some disturbance of the prostate, bladder, or kidneys, or possibly sometimes to a stricture of the pendulous urethra. Occasionally the obstacle to urination is so great that the patient has to assume some unusual position in order to urinate at all. Eve, of Nashville, lithotomized a patient who for two years before his operation had had to lie down when he wanted to urinate, and with a finger in the rectum push the stones in his bladder well up before the flow would start. One hundred and seventeen calculi were removed from this patient by the cutting operation.

4. *Pain in the bladder and penis* is common with stone, especially in children; old men may have little or none. When present, the pain is certainly aggravated by exercise. Encysted stones may cause but little pain.

5. The pain referred to the end of the penis is nearly as common in adults and old people with chronic cystitis without stone, as in those who have it. It is more intense with stone, and more often follows than precedes or attends urination. In young people, this pain, with *tendency to pull upon the penis*, is nearly pathognomonic of stone.

6. *Pus in the urine* is more often due to other causes than to stone.

7. *Vesical tenesmus*, very intense in children, and in adults and old men during an "attack of the stone," is far from being confined to patients with calculous disease. It exists in many conditions of cystitis, from whatever cause, while its absence in the old man with a small stone does not save him from the suspicion of having calculus, or excuse the surgeon for neglecting to search.

8. *Distant reflex pains* occur with stone, pains seemingly having no direct relation with the nerves supplying the bladder. Hunter's¹ well-known case of the father of Lord Cavendish is in point, where a pain in the left arm existed as a reflex symptom of stone in the bladder.

Pains in the back, loins, stomach, or thighs, may be due to vesical calculus and relieved by its extraction. Pododynia or podalgia, pain in the foot, is often a reflex symptom of irritation near the neck of the bladder or in the prostate, and may be associated with stone. It is very rare in young persons, quite common in old men, but more often absent than present in a case of stone at any age. It is a pain in the foot, usually the sole, generally occupying one of the phalanges or the ball of the great toe. This pain may be a sharp sensation, a feeling of burning, or one of intense coldness. When due to stone it disappears with the extraction of the stone, but it may exist as a symptom of vesical, prostatic, or urethral disease, or may be due to gout or to alcoholic excess when the bladder is quite sound. T. B. Curtis² has collected a number of interesting examples of this peculiar reflex pain, among them Pitha's own severe attack of cystalgia, which induced that distinguished

¹ Hunter's Works, Palmer's edition, vol. i. p. 321.

² Boston Med. and Surg. Journ., April 7, 1881, p. 316.

urinary specialist to cause himself to be sounded for stone no less than five times with negative result. Curtis also quotes Pitha's account of Dr. Reisch, who, while suffering with stone, had a sensation as though his left foot¹ were placed upon a red-hot plate. The size of the hot spot diminished as the stone grew smaller at each sitting of lithotripsy. Finally only a small point remained. Pitha believed that he had removed every fragment. Search found nothing, but the pododynia persisted and the patient declared that a small fragment of stone certainly remained. Further search discovered this fragment. It was removed, and the pain in the foot departed. Marshall Hall's² case of spasm of the sphincter ani is well known, and a very instructive case is referred to by Gross,³ as observed by John Duncan, of Scotland—that of a five-year old boy with epilepsy of two years' duration, due to stone and ceasing permanently a fortnight after successful lithotomy.

9. *Priapism*.—This, like nearly all other symptoms of stone, is more common in infants and young persons than in the adult or aged. It is not induced by or attended with sexual emotions in the adult, as a rule. A boy having the erection at first mechanically, may afterwards by association have sexual inclinations with his erections, and may become confirmed in a habit of masturbation. The erection is undoubtedly due to a turgescence of the vessels in the prostatic sinus and about the neck of the bladder, and is irritative in character.

Yet occasionally erotic desires may occur as a symptom of stone late in life. Such a case is recorded in a man of 85 by Bouvier.⁴

10. *Symptoms of Chronic Vesical Catarrh*.—The infant or young person does not very often have this symptom of stone in the bladder, while in an old man it may be absolutely the only evidence of the existence of stone.

DIAGNOSIS OF STONE.—The subjective symptoms of stone are only suggestive; no positive diagnosis can be made without the aid of physical means. The most common of these is sounding.

Many devices have been resorted to to improve this manœuvre, such as the use of a peculiar polish upon the metal sound, that it may show a scratch, or the addition of a sounding board to the searcher, or the attachment of a tube to connect the searcher with the surgeon's ear, or the adaptation of a microphone to intensify the sound.

These appliances are certainly not surgical. If the surgeon's hand is not delicate enough to detect the contact of his searcher with a stone without the aid of hearing, it will be wiser for him not to attempt to deal further with the surgery of the bladder. There is not generally any difficulty in hearing the sound of a stone as it is struck, if the bladder contains some fluid, so that the end of the searcher may be freely rotated and a little force be given to the stroke. This sound aids the touch and helps the surgeon to differentiate between a hard and soft stone; but the sound is very inferior to the sensation imparted to the fingers through the searcher when it touches calculous material.

The difficulty in finding stone is not to recognize it when it is touched, but to touch it at all, if the bladder is capacious; for it may elude all search when the bladder is full, and may be covered by the loose folds of the viscus and out of reach when the bladder is empty.

On one occasion, I was called to decide, in the case of an old man with a capacious, atonied bladder, whether stone was present or not. A prolonged search proved negative, and the decision stood against the probability of calculus. As the bladder had

¹ According to my observation, the left foot is generally the one to suffer.

² Diseases of the Nervous System, p. 339. London, 1841.

³ Urinary Organs, 3d edition, p. 197. 1876.

⁴ Bull. de l'Acad. de Méd., t. ii. p. 815. Paris, 1837-8.

been injected with water, however, I asked the patient to stand up while I drew off the fluid through a soft catheter. This he did, and as the last drops were coming away I recognized the gritty feel of a small stone against the soft catheter, and verified the fact after the bladder was empty by pushing the catheter back and forth several times. Lithotripsy promptly relieved the patient.

The Bigelow washing bottle and small tube would decide a case like this at once.

Only two instruments are essential to discover a movable stone in the bladder—a searcher, and a washing bottle and metallic tube. In many instances, no especial form of instrument is necessary, and anything thrust into the bladder—a catheter, hard or soft, a common steel sound, or a lithotrite—strikes against the foreign body and reveals its presence even to the unskilled touch. Sometimes such instruments fail. A lithotrite is too heavy for delicate handling if the stone is small. A soft instrument cannot be directed over the various surfaces of the bladder. An instrument with a long curve has so wide a sweep that it cannot be manipulated at all except in a bladder full of water, and even then it is a physical impossibility to bring its tip into contact with the *bas-fond*, just behind an enlarged prostate, the very seat of election for small stones in old men.

An instrument with a flat handle like that of the ordinary sound is not a good searcher, because it cannot be evenly and lightly rotated. A good searcher must be very light, composed of metal, and hollow, that urine may be withdrawn or water injected during the search without removing the instrument; it should have a slight bulb at its tip, and a cylindrical, corrugated handle, easy to grasp and to rotate. Probably the best instrument of this sort which has yet been devised, is Thompson's searcher.

Fig. 1215.



Thompson's searcher for vesical calculus.

This is usually made of white metal, graduated in inches, and furnished with a movable collar for roughly measuring the diameter of the stone. The common size for the adult is about 15 of the French scale, for the infant about 8.

To *sound for stone*, the patient is placed upon a table or firm couch, lying upon his back with the shoulders low, and the pelvis raised upon a hair cushion or other solid support so that it may be several inches higher than the shoulders. The thighs and legs are extended and lie flat. The bladder should, when possible, contain about three ounces of liquid. Special chairs and tables for sounding have been devised; upon them the patient is strapped and the pelvis raised or lowered at will. Like the microphone and sounding board, these devices are more impressive than useful. The surgeon may prefer to have the thighs and legs flexed so as to relax the abdominal walls. This is a matter of indifference except when it is desired to explore the roof of the bladder with the tip of the sound. In such case relaxed abdominal walls allow pressure over the bladder to bring all parts of the roof of the viscus within reach of the tip of the instrument. Most male adults can be searched as well without an anæsthetic as with it. With women and children anæsthesia is always appropriate, in the former for reasons of delicacy, in the latter to restrain spasmodic ejection of the urine, and to insure quiet manipulation,

which is essential to all accurate searching.¹ In any case when pain is great, the bladder very irritable, or the patient nervous—and particularly for a second search after one negative exploration—it is wiser to use ether than to risk failure without it.

If the stone is movable and the bladder contains fluid, when the pelvis is raised higher than the shoulders, the stone will roll away from the tender neck of the bladder and rest at the fundus behind the trigone, where it is most easily found.

The surgeon, standing at the patient's right side, introduces the searcher gently, making its heel slide along the membranous urethra and the floor of the prostatic sinus, and aiding its passage through these segments of the urethra by pressing the skin over the pubes towards the feet, with the left hand, so as to relax the suspensory ligament of the penis. In some cases the whole search is made less painful by keeping the ligament so relaxed through the entire sitting. When the heel of the searcher enters the bladder it should be carried gently down the inclined plane formed by the base of the bladder until it is arrested. Most often the stone will be struck at this point. If not, then the toe of the searcher should be gently rotated as far as it will go, first toward one and then toward the other side of the bladder. Next, the searcher is drawn forward, well inclined toward one side, and by rotating the cylindrical handle, gentle taps are given to the wall of the bladder, along the entire side as far forward as the instrument can be drawn. It is then slid back to the fundus along the course it has just traversed. This double passage is repeated on the other side of the bladder. Next, the beak of the sound is reversed, and the whole floor of the bladder is swept by to-and-fro lateral motions of its tip, as it is brought forward to the vesical neck and carried back again to the fundus.

If the result is negative, some water may be drawn off and the search repeated, or, an expedient which I have found of great value, the patient may be asked to stand erect with the searcher still in his bladder, and the urine may be drawn off through the searcher while he is standing, leaning forward upon a chair for support. As the urine flows away, the beak of the sound should be held quite near the neck of the bladder, and rotated from side to side until every drop of urine has passed. It is difficult for even a minute stone to escape detection by this method.

Should a stone be touched, the bulbous tip of the searcher passed over its surface will indicate whether it is rough or smooth. The character of the click produced by tapping the stone gives a clue to its composition, a dull, low-pitched sound indicating a soft phosphatic stone, while a clear, high-pitched click indicates uric acid or oxalate of lime.

If, when the patient is quiet, the sound strikes a stone in being rotated first to one side and then to the other, it is probable that two stones are present. Better evidence as to the composition of the stone is furnished by the condition of the urine and the crystals it contains, than by the nature of the click. Thus, if crystals of oxalate of lime, uric acid, cystine, or triple phosphates abound in the urine, it is fair to presume that at least the last coatings of the stone are composed of similar crystals.

Another point in the diagnosis of stone is its size. This may be approximately ascertained as follows: The searcher is pushed to the back wall of the bladder, and then gently brought forward, tapping the vesical wall on the side upon which the stone lies until the latter is touched. Now the sliding collar on the shaft of the instrument is pushed down to the meatus,

¹ The injection of a four-per-cent. solution of the hydrochlorate of cocaine in some cases makes the use of ether unnecessary.

and the tappings on the surface of the stone are continued as the searcher is withdrawn, until a certain tap clears the stone and strikes the bladder in front of it. The graduations on the shaft of the searcher, between the sliding collar and the meatus, mark approximatively one diameter of the stone. The actual diameter is best ascertained with a small lithotrite, and multiple stones are best demonstrated by seizing one of them quite firmly in the jaws of the lithotrite, and using this as a searcher to strike one or more stones on either side.

The size of a stone may often be estimated by passing one or two fingers into the rectum and feeling the stone between the finger and the searcher, or, in a thin person with a large stone and small prostate, by bi-manual palpation, one or two fingers in the rectum, while the other hand pushes down the abdominal wall over the bladder. With large prostate and deep *bas-fond*, a finger in the rectum will sometimes elevate a small stone within the reach of the searcher.

A stone may still escape detection by being encysted or situated in a hernial pouch, or behind an hour-glass contraction, or wrapped up in a blood-clot, or in a mass of mucus so as to yield no sound or sensation of hardness to the searcher.

In cases of grave doubt, the bladder may be examined with straight and long curved sounds as well as with the searcher, and by lifting the floor and depressing the roof of the bladder so as to bring the point of an instrument into contact with every part of its wall. The lithotrite also would be of service in finding a stone enveloped in blood or mucus, as would extreme distention of the bladder with warm water, and a change of position to throw a stone out of a large pouch or double bladder, if there should be any reason to believe this condition to exist. Furneaux Jordan,¹ in one case of tight stricture, sounded with an acupuncture needle through the perineum, and struck a stone.

But all these means occasionally fail when a stone is very small. In such case no searcher approaches the accuracy of the washing bottle and small metallic evacuating tube, straight or curved—the Bigelow apparatus for washing in litholapaxy. Such a tube being introduced, and the apparatus so managed that not a particle of air enters the bladder, the swash of the water will certainly bring any small stone into contact with the tube, and the sharp click can be plainly felt by the surgeon or heard by any one placing his ear over the bladder. This means in my hands has proved successful in more than one instance when all other efforts had failed.

Notwithstanding the accurate means of investigation now possessed by the surgeon, it is still possible occasionally to overlook a stone, and in a doubtful case at least two examinations ought to be insisted upon before giving a final opinion; and the second of these examinations should be practised with the patient under the influence of ether, and should be made with the searcher, washing bottle and tube, and lithotrite. Even then an error may be made: a small tumor, encrusted with crystals, may be declared to be a stone; or a calculus may be overlooked, lying in a cyst, sacculus, or pouched ureter, or shrouded in a blood-clot or mass of viscid mucus.

The fact, moreover, is of record that the very best surgeons (Cheselden, Morgagni, Abernethy, Dupuytren, Chopart) have failed to find large stones in the bladder, which an autopsy has revealed, while others, equally distinguished, have cut for stone and found none. To say nothing of a host of minor operators, the great Cheselden cut three times for stone and found nothing. Dupuytren, Roux, and Crosse, too, committed like errors.

¹ Surgical Enquiries, 2d ed., p. 284. London.

Chronic thickening of the bladder, with or without tumor, ulcer, or heterologous deposit; feces in the rectum; pelvic exostosis; a displaced uterus; the hard pelvic brim, with a thin bladder-wall lying against it; a prominent sacral angle, and many other physical irregularities, have been mistaken for stone.

In one case with which I am familiar, a small stone was felt in a child. The lateral operation was performed. The bladder was distended, and a gush of urine followed the withdrawal of the knife. A search for stone was now instituted without result, when finally it occurred to the operator to examine the clotted blood in the vessel containing the urine, and there a small stone was found, evidently having been expelled by the first gush of urine.

Nourse is quoted by Gross¹ as reporting a case wherein nine calculi were lodged in six sacculi; and, although stone was once touched by the searcher, numerous subsequent examinations failed to detect it. He refers also to Pott's case of calculus in a hernial pouch of the bladder situated in the groin, and to Hartmann's, where a stone weighing three ounces was found in a hernial pouch of the bladder situated in one of the labia of a woman.

When very large stones have escaped detection, it is supposed either that the sound entered between the stone and the wall of the bladder, and was there so tightly held that it could not be rotated to strike the stone (but why the gritting sensation was not experienced, it is hard to understand)—or that the searcher failed to enter the bladder at all, being rotated in some dilated portion of the urethra mistaken for the bladder, as in two cases noted by Pelletan.² A pouched prostatic sinus may also be mistaken for the bladder in an old man, and thus a stone be overlooked. I have encountered an instance of this sort, and others are on record in which, the prostate being destroyed by suppuration (Muller, Civiale), the patient has been cut into this cavity and not into the bladder, and no stone has been detected until subsequently revealed by an autopsy.

Hence it would seem that the masters of surgery in former days had good reason in formulating the cardinal rule in lithotomy, that even after the presence of a calculus had been recognized, and the patient was placed upon the table, if the stone could not be struck then and there, it was better to defer the operation. It is difficult to imagine sometimes what it has been which has deceived the skilled touch, but grave errors have arisen, and their lesson must not be disregarded. In many cases where a doubt suggests itself that there may be no stone, although something is struck by the searcher which resembles stone, a small lithotrite, by grasping the foreign body and moving it, will clear up all uncertainty.

Finally, it must be remembered that sounding a patient for the first time is an operation not devoid of risk. Fatal cystitis has been occasioned by it in more than one instance (Prout, Fletcher, Civiale, Crosse, and others). No unnecessarily prolonged, rough, or repeated manipulations should be practised at a first sitting, or indeed at any time.

THE PREVENTIVE TREATMENT OF STONE.

Prevention, as a treatment for expected stone, is generally first thought of after a patient has passed a renal concretion. But the question may arise earlier than this, in connection with a possible inherited tendency to calculous disease, or in directing a course of life for a patient who persistently voids large quantities of crystals. Of the two great classes of stone, one, the primary, is of consti-

¹ Op. cit., pp. 205-207.

² Ségallas, *Essai sur la Gravelle et la Pierre*, 2me éd., p. 155. 1839.

tutional or diathetic origin, and requires general measures to counteract the tendency to its production; the other, secondary, is of local origin, and local preventive measures are here vastly more important. The latter are almost too obvious to require mention. They involve all the physical means employed for the relief of obstructive urethral and prostatic disease—removal of nuclei, the use of the catheter, vesical irrigation, medicated injections, and other means for controlling vesical catarrh—for without catarrh it is impossible for secondary stone to form. In the kidney and ureter it is often impossible to apply local measures, and here it is, therefore, that secondary stone once originated most often goes on, uninfluenced by any measure brought to bear against it. A somewhat brighter future for these conditions is promised by nephrotomy.

There are certain general measures, however, which seem to oppose secondary stone formation even in the kidneys; these are the use of—

- (1) A milk diet, when well borne by the stomach;
- (2) An abundance of bland, diluent drinks;
- (3) Tonics;
- (4) Mineral acids (sometimes);
- (5) Alkalies (sometimes);
- (6) Benzoic acid—occasionally—or the salicylates.

(1) A milk diet, if well borne, sometimes reduces catarrhal inflammation of the urinary mucous passages to a remarkable extent. Should a nucleus be present, however, no amount of milk diet can cure, although it may moderate, a local catarrh of that portion of the membrane upon which the foreign body lies.

(2) Diluents act by lessening the irritation of the mucous surface through the greater blandness of the fluid which bathes it. In this way most of the mineral waters act which seem to have power in reducing chronic catarrhal urinary conditions. Such waters as the Bethesda, Poland, Olysmic, Glen Summit, Mountain Valley (Arkansas), certainly do not act by virtue of any mineral ingredients, and are not, as a rule, much more valuable than filtered rain water taken very freely. They wash out the urinary passages and reduce irritation, but they do not dissolve stone, either alkaline or acid. The waters of Wildungen and Contrexville probably act in a similar manner, although an especial claim is made for the latter that it dissolves mucus and tends to cause a diminution in the excretion of phosphates. I have no personal knowledge of the truth of these claims.

(3) Tonics act by improving the digestion and the vitality of the tissues, and (4) mineral acids act in the same way, and not directly through the urine. In a catarrhal condition of the urinary organs the administration of acid generally does not render the ammoniacal urine acid, but, by making the urine more dense, it may increase the grade of the catarrh, and consequently intensify the alkalinity of the urine.

(5) Alkalies, on the other hand, sometimes agree very well, and by diminishing the acidity and acridity of the urine at the kidney, lessen the grade of the catarrh, and sometimes even gradually restore normal acidity to the urine.

(6) Benzoic acid in 10-grain or even larger doses, in capsules, will sometimes arrest ammoniacal changes and allay catarrh, but it is a substance not well borne by most stomachs. Salicine, salicylic acid, the salicylates, and even oil of wintergreen, chlorate of potassium, and naphthaline, have been found serviceable in some cases. Sometimes useful, they are generally powerless to do good, but where they do act their influence is antagonistic to secondary phosphatic stone formation.

Concerning the formation of *primary acid stone* something more may be

said. It is difficult to speak definitely of this class of cases, with the exception of those included in the uric-acid group. A primary acid nucleus is most often composed of uric acid and the urates, and inherited tendencies to stone usually manifest themselves by precipitation of the same salts.

Here it is, fortunately, that preventive measures are of most avail; indeed, in this direction only has any serious advance been made.

A tendency to lithiasis being recognized by the constant or intermittent occurrence of urates and uric acid in the urine, and especially after one kidney stone has been voided, the problem which arises is, How shall another nucleus be prevented from forming? The answer may be best given under six heads:—

- (1) Regulation of diet.
- (2) Attention to exercise.
- (3) Promotion of elimination by other channels.
- (4) Dilution of the urine.
- (5) The use of solvents.
- (6) Attempts to avoid crystallization in colloidal forms.

(1) Thompson has given this subject more study than any other surgeon, and with a greater measure of success. Uric-acid causation unquestionably lies behind the kidney, in the state of the blood furnished to that organ; and the blood again derives its qualities to a considerable extent from the quantity and quality of the food, the state of the digestion, and the effect of air and exercise upon the blood. Physiology would naturally suggest that when the urates are in excess, the diet should be limited in its nitrogenous elements. In practice, however, as Thompson has taught and experience daily proves, the very opposite is the case, and it is the alcoholic, saccharine, and fatty elements of food, and not the meats, which have to be cut off when we propose to reduce habitual tendencies to uric-acid formation.

The reason for this seems to be that these elements tend to make the liver "torpid," as it is called, and in some way to interfere with the proper elaboration of the blood.

In practice, manifest advantage arises from giving up alcohol, especially all sweet fermented and malt liquors, and the stronger wines, Madeira, port, and sherry. Beer, champagne, and liqueurs are very harmful, unless an exception be made for very dry champagne. If some alcoholic stimulant must be taken for the stomach's sake, or on account of advanced age, or for other reason, a choice should be made among the sound, light, red wines of France—the Bordeaux wines—and the thin Rhine wines; or, if more alcohol be required, a little very old brandy, whiskey, or gin, well diluted in water, may be used.

Sugar in any form is harmful, and should be discarded as far as possible from the dietary. Of the different kinds of fat, the same remark holds good, but to a less degree. Fried fats, rich gravy, and pastry are to be condemned; even milk and pure butter are sometimes harmful, but not always so. These latter substances do not alter in any degree the solid constituents of the urine, if we may place confidence in the results of the experiments of Dr. Böcker, as quoted by Garrod,¹ which show that "no influence whatever is exerted on the excretion of water, urea, uric acid, or any other constituent of the urine, by taking from about a quarter of an ounce to three ounces of butter daily."

A proper diet is one composed of meat, especially poultry and fish, bread, all the cereals, green vegetables, salads, and fruits, with sometimes milk, butter, and eggs, if the latter substances agree with the patient's digestion.

Certain kinds of food appear to possess special value. The experiments made conjointly by Heller and a friend, also referred to by Garrod,¹ are sugges-

¹ Uric Acid, its Physiology and its Relations to Renal Calculi and Gravel. *Lancet*, April 21, 1883, pp. 670-673.

tive. Heller first found out how much uric acid he and his friend excreted daily under a stated diet. Then Heller lived for a week on rye and wheaten bread, his friend on rye bread alone, water being their only drink. The uric acid was gradually replaced by hippuric acid, and finally only a trace of it remained in Heller's urine, none at all in the urine of his friend. During the next week, having returned to ordinary diet, the hippuric acid diminished and the uric acid reappeared.

(2) Exercise in the open air is a prime factor in the reduction of uric-acid deposits. Any one subject to these deposits can bear testimony to the value of a summer in the woods, or of horse-back exercise persistently practised.

(3) The elimination of uric acid and its compounds by other channels than the kidney, is an important element in the preventive treatment of primary stone. It is on a par with the treatment of gout as carried out at Carlsbad, and indeed the dietary regulations are founded on the same basis. The plan is to act upon the liver and intestinal glands by one of the natural mineral waters containing sulphate of sodium and sulphate of magnesium in solution. Thompson has proved that a dose of one of these waters will be amply cathartic, although the actual amount of sulphate of magnesium and sulphate of sodium in the draught be only one-fourth the amount required, if the same drugs are bought of the apothecary.

The waters which are most suitable are the Hunyadi Janos and the Friedrichshall. The former is nearly three times as rich in the requisite ingredients as the latter, and may be used in a correspondingly smaller dose. Both should be taken warm, fasting in the morning, and in some instances the effect is enhanced by diluting the draught, the Friedrichshall one-third, and the Hunyadi more than one-half, with hot water. The daily dose should be sufficient to cause one free and rather watery stool after breakfast, or even two at the beginning of a course. A small claret glass of Hunyadi, or a moderate tumblerful of Friederichshall, is the customary dose to begin with, but this may be reduced in most instances as the course goes on.

At the beginning of such a course, and occasionally during its continuance, a blue pill may be administered with advantage, or a compound rhubarb pill (5 grains) with the addition of $\frac{1}{8}$ — $\frac{1}{12}$ grain of blue pill (Thompson).

Such a course should continue about two months, the mineral water being gradually reduced in amount each morning, and replaced by hot Carlsbad water, at a dose of about one tumblerful. The course may often be repeated with advantage after an interval of three or four months, and many patients will continue a light morning dose for years, with apparent advantage and no depleting effect.

Where the patient is poor and cannot afford mineral waters, an efficient morning dose of Glauber's salt, with a slight addition of sulphate of magnesium, may be substituted. This course freshens the patient, diminishes dyspepsia, and increases the sense of comfort and well-being, while it unmistakably reduces the amount of urates and uric acid in the urine.

Another method of reducing the amount of uric acid is now undergoing investigation. Garrod has observed that the urine of a sucking calf contains uric acid, but that when the calf gets older and lives on grass, the uric acid disappears and hippuric acid takes its place. Garrod also found that if the urine of a herbivorous animal was added to human urine and allowed to stand, no uric acid could be detected in the specimen, and that a solution of uric-acid calculus mixed with carbonate of lithium and added to the urine of a horse, failed to yield, when kept a few hours, any uric acid.

The inference was plain, that the renal epithelia of the herbivora were capable of excreting uric acid, but that the hippuric acid in solution subsequently destroyed it.

Garrod also investigated the conversion of benzoic acid into hippuric acid in the animal economy, and is now experimenting with hippurates and benzoates of sodium and potassium with results that he at present only indicates as having given him "great advantage" in the treatment of gout, of gravel, and of calculus.¹

(4) Simple dilution of the urine is another useful means of counteracting tendencies to acid stone formation. If properly carried out, no harm comes of it, and at least negatively it has value, for the greater the quantity of water with a given amount of solids to be eliminated, the less will be the tendency to precipitation. Many individuals with concentrated acid urine have very little thirst, and are habitually light drinkers of water. A habit of drinking water freely may be encouraged. During meal times it is better to drink hot than cold water. The digestion is aided by such draughts. Between meals at any time a glass of water may be taken, and if it is not too near a meal, iced water is as harmless as anything else. On retiring, also, a glass of water is particularly useful, since it serves to dilute the urine secreted during the night, which is more concentrated than that secreted at any other time. Filtered rain water is excellent for these purposes of dilution, or any of the simple diluent spring waters—the Bethesda, Poland, Mountain Valley, etc.

(5) The use of solvents is a very prompt method by which urates and uric acid may be made to disappear, but it has less real value than those already mentioned for continuous use. By administering the citrate or the acetate of potassium, or the bicarbonate of sodium or potassium, or by the use of Vichy, Buffalo Lithia, or other natural alkaline mineral waters, the urates and crystals may usually be made to disappear from the urine, and the uric acid storms, as they have been called, may be calmed.

These agents are of undoubted value, and in many conditions approaching an emergency can hardly be dispensed with. Their promptly effective action so long as the stomach is tolerant, is a valuable aid to the surgeon. For prolonged use, and when the patient's tendencies toward acid formation are very strong, the alkaline solvent treatment is not always available, since it may induce dyspepsia and lead to anæmia. When alkalis are used, they should be exhibited during the third hour after eating, at the time when the acid in the chyme is neutralized, or has been reabsorbed. Then the alkali is promptly absorbed and exerts its maximum effect upon the urine.²

In my experience, if a course of alkalis is suitable and necessary for a very long period in the preventive treatment of stone, the boro-citrate of magnesium is a good preparation. This nearly tasteless powder may be taken dry upon the tongue in a dose of ten or more grains, and washed down with a swallow of water. It seems to tax the stomach less than the citrate of potassium, and some patients assert that it is of service. Like other alkalis, it should be given during the third hour after eating.

The formation of oxalate-of-lime crystals, as is well known, may be modified by the use of dilute nitro-muriatic acid, and the aid of this drug may be invoked in acute outbursts of uric-acid or oxalate-of-lime crystallization when digestion is at fault. To prevent cystine formation, Beale³ uses carbonate of ammonium freely.

(6) An attempt to avoid crystallization in colloidal forms, is, perhaps, the most scientific direction that the preventive treatment of stone can take, but it is at the same time the most vague. The main colloid for acid stone is

¹ Loc. cit., p. 673.

² Ralfe, Observations on Urinary Pathology and Therapeutics. Lancet, Nov. 9, 1879.

³ Lancet, August 30, 1884, p. 263.

probably mucus, and a little scratching of the mucous membrane by the sharp points of crystals, or irritation by concentrated urine, is sufficient to call out enough mucus to act as a colloid and determine the character of the crystals. Hence all efforts to make the urine bland and abundant are justified on purely scientific grounds. But the question is, Does any substance exist which militates directly against stone formation, either by reducing the colloids or preventing their action? To this no answer can be given, but a substance has of late been brought before the notice of the profession, which perhaps acts in this way. I refer to the fluid extract of hydrangea which has been mentioned during the past few years a number of times in the American medical weeklies, as an agent calculated to arrest paroxysms of renal colic, and even to relieve them when present. My experience with this drug is limited, but I think that I have seen some slight advantage follow its use in half-drachm or drachm doses after meals. Cider also, as an habitual drink, has given good results in my experience. The cider need not be absolutely sweet; ordinary bottled cider answers all purposes, or even cider which is slightly hard.

ELECTROLYTIC TREATMENT OF STONE.

That the electric current influences crystallization has long been known. Ord states that magnetic currents cause oxalate of lime crystals to reach an unusually large size, and refers to Bridgman as asserting that submorphous forms of crystals (colloidal) appear sooner under a mild galvanic current than they would otherwise do in the same liquid. The construction of stone may thus be aided by electricity, and disintegration of calculi has been effected by the same agency.

Bouvier-Demortiers first thought of dissolving stones with the voltaic pile, and Gruithuisen, in 1813, found experimentally in the laboratory that with platinum points and a number of elements stones might be pierced by this means. In 1823, Dumas and Prévost¹ found that a fusible calculus of 92 grains, under the action of a pile of 120 couples, recharged hourly, lost 12 grains in 12 hours, and after 28 hours became a friable mass which crumbled on the slightest pressure. They experimented on a dog, and found that the process could be conducted without injuring the bladder. They then experimented in the human bladder, but, with negative results, since uric-acid calculi, being formed of one substance, were not suitable for voltaic dissolution. Dumas and Prévost injected into the bladder a solution of nitrate of potassium, hoping to make by electrolytic action a soluble urate of potassium, but the experiment proved negative.

Leroy d'Étiolles followed up these attempts, but came to negative conclusions. Bence Jones did the same, in England, in 1852. Erckmann,² under the auspices of Dr. Raymond, announces some successful experiments. Leroy d'Étiolles (fils),³ who saw the patients of Erckmann, does not consider the facts conclusive or the cases established, and to-day electrical lithomaxia has no recognized place among the legitimate operations for stone.

SOLVENT TREATMENT OF STONE.

Pliny⁴ speaks of the ashes of snail-shells as a proper solvent for stone. Hippocrates and Galen do not appear to have had confidence in any sub-

¹ *Annales de Chimie et de Physique*, Juin et Juillet, 1823.

² *La lithomalakie électrique*. Paris, 1863.

³ *Op. cit.*, p. 540.

⁴ *Hist. Nat.*, lib. xxx. cap. viii.

stance, but since Pliny many investigators have given time and attention to a study of the medical treatment of stone. The laity almost uniformly believe that stone may be dissolved by medicine, and tons of pills and powders, rivers of supposed solvents, and oceans of mineral waters have been consumed by the victims either of stone or of their imaginations, in the delusive hope of cure. Aretæus, in the second century, introduced quicklime as a stone-solvent, and Paulus Ægineta, in the seventh century, mentions that some persons thought well of goat's blood. Avicenna (tenth century) was quite convinced of the efficacy of the impure carbonate of potassium, but his prescriptions were nauseating compounds containing a number of absurd ingredients in addition to the usual alkali, and his methods did not retain favor with the profession.

Later authors, from Basilius in the fifteenth century to Mrs. Joanna Stephens in the eighteenth, used the same alkalies—potassa, lime, and soda—in simple combinations with vegetable diuretics, given by the mouth or injected into the bladder. Many contented themselves with such remedies as the infusions and decoctions of various plants, roots, bulbs, or fruits, carbonic acid in water, distilled water, goat's blood, etc. The names of Blackrie, Chittick, Darci, Morand, and Girardi become familiar in looking over the literature of this subject.

In France the first sign of intelligent direction of the solvent treatment appeared when Fourcroy and Vauquelin did what they believed to be wise in using dilute acids in the treatment of alkaline stones, and alkalies in that of acid concretions.

No remedy reputed to be a stone solvent has had such renown as that of Joanna Stephens. Physicians and patients in England became generally convinced of its value, and the English Parliament, after a long inquiry, under full conviction of its worth finally, in 1739, bought the secret of Mrs. Stephens at the modest figure of £5000.

The medicines so purchased proved to be a powder of calcined egg-shells and snails; a decoction of herbs with soap, ashes of swine's cresses, and honey; and a pill of calcined snails, wild-carrot seeds, burdock seeds, ashens keys, hips and haws—all burnt to blackness—soap, and honey.¹ These compounds apparently effected wonders as long as they were secret remedies, but, their composition once disclosed, they soon lost their charm and fell into disuse.

So celebrated did these remedies become that Morand was appointed by the French Academy to go to London to look into the merits of the Cheselden cutting operation, and the cures by the Stephens remedies. On his return he reported² that the remedy had been tried upon forty patients, in twenty-two of whom stone had been touched with a sound. Five of the latter were finally cut, and their stones showed no evidence of erosion. Morand found that some patients were soothed, and that some passed small calculi, worm-eaten in appearance, after taking the remedies; therefore he thought favorably of the medicines, although none of the patients reported as cured would allow themselves to be sounded again.

But the most pungent criticism upon the remedies of Mrs. Stephens, is that each of the four patients whose cures were vouched for by the trustees appointed by the Government, and who had refused to allow themselves to be sounded, died with stone in the bladder, as proved by post-mortem examination in each case.³

¹ Gentleman's Magazine, June, 1739, vol. ix. p. 291.

² Mém. de l'Académie des Sciences, Années 1740-41.

³ Alston's Lectures on the Materia Medica, vol. i. p. 268. London, 1773.

This experience was repeated in other alleged instances of cure, as may be seen by looking into the rather extensive literature of the period.¹ Many patients, on the other hand, who took these remedies, had no stone at all, but being relieved by the alkali of certain symptoms, testified that they had been cured of stone.

As soon as it began to be supposed that the lime in burnt egg and snail-shells effected the cure, Whytt, of Edinburgh, devised a cure by lime-water and soap, and published, among many others, the case of one David Miller, who took three pints of lime-water and an ounce and a half of Castile soap daily, and passed some broken fragments of stone, and in whose bladder, when he died eleven years subsequently, no stone was found.

Mascagni, in Italy, published his own case as an example of cure by drinking Seltzer water and a weak solution of bicarbonate of potassium. He had lumbar pains, and passed some acid gravel during the treatment.

Heller² reports the cure of a case of urostealith calculus, by administering two drachms of carbonate of sodium daily. The patient voided considerable masses of urostealith, and was pronounced cured in a fortnight.

Chevalier and C. Petit, in France, stand at the head of the investigators into the value of natural mineral waters, notably Vichy, in dissolving stone; but some of their conclusions have not been confirmed, as, for instance, that triple-phosphate calculi are acted upon more efficiently by Vichy water than stones of uric acid (Petit); and Petit again made a famous mistake³ in asserting the cure of stone in a well-known gentleman, from whose bladder a stone as large as a hen's egg was removed after death.

The committee appointed by the Academy of Medicine to examine the claims of Petit, decided against the probability that urinary concretions, "large enough to constitute actual stones," could be cured by the waters of Vichy; yet even to this day patients with stone and gravel go to Vichy under the belief that their stones can be dissolved.

The most serious scientific effort which has been made to establish the solvent treatment of stone, is that of Roberts,⁴ of Manchester. Basing his conclusions upon a large number of careful experiments, performed upon stones with various alkaline solutions out of the body, Roberts finds the carbonate of potassium to be the best solvent for uric-acid concretions; much better, he thinks, than the salts of lithium or sodium. If the solution be too strong, an alkaline bi-urate coats the stone, and further solution ceases, but such excess of alkalinity can hardly be maintained in the body. The citrates, acetates, and other alkaline salts given by the mouth, are all eliminated as carbonates in the urine, and the salt which in practice Roberts finds most effective, and least likely, by long-continued use, to upset the stomach, is the citrate of potassium.

But the citrate of potassium may prove to be too diuretic, making the alkaline solution of urine too feeble to be effective. In such case he substitutes for it, in part or wholly, the bicarbonate of potassium or sodium, or the liquor potassæ. The proper dose of the citrate, for an adult, is from forty to fifty grains in a gill of water every three or four hours, so that the daily dose shall be six drachms. The urine may become cloudy from precipitated phosphates, but this does not hinder solution, which continues unless the urine becomes ammoniacal, when all action ceases. Hence an essential condition is that

¹ James Parsons reports twelve such cases. (A description, etc., London, 1742.) Horace Walpole's case is in point. Thompson quotes it, and Le Roy d'Étiolles (fils) alludes to several very interesting cases.

² Heller's Archiv, Bd. ii. S. 2. 1845.

³ Leroy d'Étiolles (fils), *Traité pratique de la gravelle*, p. 531. Paris, 1869.

⁴ *Urinary and Renal Diseases*, Second American Edition, pp. 298-321. 1872.

the urine shall be normally acid at the start, and shall not become ammoniacal during the course of treatment. Roberts has continued these high daily doses of the citrate for many months without producing anæmia or gastric derangement.

On account of the vigorous presentation of his method by Roberts, no opposition has been made to his conclusions, as a rule, and his faith in the citrate of potassium has caused it to be generally accepted by the profession; but quite recently Garrod¹ has repeated the experiments of Roberts, and claims that the latter was wrong in his conclusions as to the relative efficacy of the potassium and lithium salts. He shows, indeed, that "the results were, in each case, more than fifty per cent. in favor of the carbonate of lithium." Garrod explains Roberts's error on the ground of his having used an impure lithium salt, or having employed only very weak solutions. The irritating action of lithium salts upon the stomach is also denied by Garrod, who appears to use the carbonate, but is not specific in his directions. He says:—

The only effect I have ever noticed has been that, when the quantity has been increased beyond a certain amount, a little tremor of the hands is produced, which passes off at once on the diminution or omission of the dose of the salt. I have known patients of their own accord continue the use of lithium salts for more than ten years, with the effect of entirely preventing the recurrence of the symptoms to remove which they had first been prescribed, and without the production of any injurious effects. For myself, I have not the least doubt as to the value of lithium salts as therapeutic agents, and am convinced that, by their employment, depositions of uric acid in the renal organs can, to a large extent, be prevented. Free dilution and administration upon a fasting stomach are points of much importance, which should be attended to in the administration of alkaline remedies. I have been much in the habit of using potassium with lithium in the form of the citrate or the carbonate; the former to give neutralizing, the latter to increase the solvent power.

This certainly sounds promising, coming from such a source. The citrate of lithium is more soluble and more easily borne by the stomach than the carbonate. It may be given in from ten to thirty grain doses.

Injections of various substances into the bladder for the purpose of dissolving stone have been used successfully; Coulson alludes to a case in the practice of a Mr. Rutherford, but all these efforts have failed to favorably impress either the profession or the public, and Roberts demonstrates that the solution of acid stone by injection of alkalis is impracticable. Almond-oil and lemon-juice were injected by Baronius, the former as a calming agent, the latter as a solvent. Whytt used lime-water, as did also Butler, Campbell, and Rutherford. Hales tried, in animals, continuous irrigation through a double current catheter. Gruithuisen made some experiments in 1813, and Cloquet followed in 1821. He preferred distilled water as the substance to be injected. Attempts have been made to surround the stone in a rubber bag, and then to throw acid into the bag. Leroy d'Étiolles² made such attempts, and condemned not only them but all similar methods of treatment, and, following up the subject afterwards (1839-41),³ decides absolutely against the practical utility of all forms of solvent treatment, whether used by the mouth or directly by injection. Hoskins's⁴ nitro-saccharate and acetate-of-lead injections are of later date, their object being to disintegrate the calculus by double decomposition; but this method lacks the confirmation of practical success, as does also the use of

¹ *Lancet*, April 21, 1883, p. 669.

² *Exposé des divers procédés pour guérir de la pierre*. Paris, 1825.

³ *Lettres à l'Académie de Médecine sur la dissolution des calculs*.

⁴ Coulson, p. 593, quoting from *London Journal of Medicine*, Oct. 1851.

acetate of lead (one grain to a fluidounce of water, with a few drops of acetic acid).

Some reserve, perhaps, must be made in favor of the injection of dilute acids to dissolve phosphates precipitated in the muco-pus in catarrhal conditions of the bladder, and as a prophylactic against the tendency to phosphatic re-accumulation. Indeed, Brodie is quoted as having used a solution of two and a half minims of strong nitric acid to the fluidounce of water, injected through a double catheter for fifteen to thirty minutes two or three times a week, and as having succeeded in thus dissolving a phosphatic calculus.

In face of historic evidence, however, there can be but one deduction regarding the practical value of the solvent treatment of stone, namely, that it has no general applicability; and yet in spite of all evidence, and of all history, the virtues of various pills and waters are proclaimed to day by the proprietors of these nostrums, and by some of their dupes, as boldly as if Mrs. Stephens and her calcined shells had never existed, and the advertisements of mineral springs abound in seemingly well-attested instances of cure of stone.

A large stone cannot be dissolved, if for no other reason, on account of its animal matrix. For even allowing that the penetrating influence of the solvent could decalcify the outer layers to a considerable depth, yet the tenacious organic skeleton would remain adherent, arrest further solvent action, and form the best possible bed of colloid for new stone formation.

No pretence is now made in any scientific quarter that any stones can be dissolved by internal treatment, except those composed solely of uric acid, urates, or urostealith.

Beale's¹ recent announcement of the good effect of large doses of carbonate of ammonium in causing cystine to disappear from the urine, and the recurring passage of small cystine calculi to cease, must be borne in mind, and may make it possible to add cystine calculi to the list of those which we may hope to dissolve by the internal use of medicine. One of Beale's patients took 50 grains of ammonium carbonate three times a day, in a little water, for nearly three years.

Oxalate of lime and the phosphates, not uncommon substances to form layers in alternating calculi, are an absolute bar to solvent action. Ammoniacal urine is so likewise; and indeed so many conditions militate against the solvent method, that it is only the fascination lent to it by the possibility of success which has induced so many honest and competent observers to approach it. Yet being a possibility, it is a legitimate resource in those cases in which more radical measures are contraindicated, notably in dealing with small stones in the kidney. The best method is undoubtedly the one proposed by Roberts, possibly substituting citrate of lithium for the citrate of potassium, as suggested by Garrod. Success can only be hoped for after a very long course, and when the stone is quite small and the urine normal, or at least not ammoniacal. The deposit of sediment (phosphates) from the urine which may take place during the course is no indication that the stone is being dissolved, for it is an amorphous phosphate due to alkalinity of the urine, and not a dissolved urate, and the stone may still be actually growing in size.² Nor must it be forgotten that there is a possible element of error inherent in all methods of treatment by internal medication, or by the free use of mineral water, namely, the occurrence of a very positive and prolonged change in the specific gravity and reaction of the urine in which the stone lies bathed, a circumstance which would favor spontaneous fracture and disintegration, and might lead to spontaneous evacuation of the débris. This method of cure certainly sometimes occurs at mineral springs.

¹ Lancet, Aug. 30, 1884, p. 363.

² Thompson, Clinical Lectures on Diseases of Urinary Organs, 6th ed., p. 129. 1882.

It is not worth while to attack a stone in the bladder, however small, by the solvent method, whether through the mouth or by injection, for the former plan is far too uncertain, and the latter requires vastly more instrumentation, even if it could succeed at all, than the single sitting of lithotripsy by which the foreign body can be removed. Acid injections are a valid and valuable means of local medication against tendencies to recurrent phosphatic accumulations. The internal measures in vogue possess a symptomatic value apart from their alleged worth, in that the effect of the alkali is often soothing, and they may be used in any case to comfort the patient, though he should not be deceived into hoping too much from them.

PALLIATIVE TREATMENT OF STONE.

In some cases radical treatment is not justifiable. Such are cases of large kidney-stones and phosphatic renal concretions where nephrotomy is not practicable, and all cases of vesical calculus in which, from the size or other peculiarity of the stone, or from the age, disease, or other condition of the patient, operation is contraindicated. In these cases, whether the stone is renal or vesical, the general outline of palliative treatment is the same. Milk diet is often a valuable adjuvant to treatment, as is sometimes a decided course of alkalies, as proved by the many patients who believe themselves bettered by taking the various advertised nostrums. The same remark applies to the use of the natural mineral waters. Both these remedies sometimes fail on account of their diuretic quality, for the mechanical effect of too frequent urination, when there is a foreign body in the bladder, is irritating.

The conduct of a case of this sort involves a judicious selection of anodynes and alkalies, rest, tonics, diet, and symptomatic local treatment. Much comfort may often be afforded when cure is impossible.

SELECTION OF A METHOD OF RADICAL TREATMENT.

Certain general conclusions have been established by statistics, namely, that the female tolerates lithotomy better than the male; the child better than the adult; the patient with diseased kidneys less well than any other. It has been proved, also, that the size of the stone influences the rate of mortality, and that an operation which may be best for one size of stone is less suitable for another. But statistics cannot demonstrate that one operation is better than another, simply because a given operator obtains brilliant results by a given method. There is no place in the literature of the present day for the heated discussions which flourished in France toward the middle of the present century as to the relative merits of lithotomy and lithotripsy, as a general operation for all cases. The present discussion is narrowed down to more exact limits, and deals with special indications furnished on the one hand by the patient, on the other hand by the calculus, for the use of one or the other operation in any of the various modifications of each.

Moreover, a new element has entered into the computation, which has not yet found its way generally into print as a factor in the problem of statistics and mortality; that element is the new operation for stone—litholapaxy. Even Coulson, in his admirable chapter on statistics in his last edition, 1881, hardly mentions it. Enough material in this line has not yet been collected to seriously affect old statistics, but that it is an element which must modify them cannot be denied.

Much reiteration of well-known facts and figures is unprofitable, and I shall content myself with as small a display of tables as possible, reserving the practical consideration of the relative efficacy of the different methods for the section of this article which considers the choice of an operation as regards: (1) the peculiarities of the patient; (2) the peculiarities of the stone.¹

LITHOTOMY.—The phenomenal success of Martineau,² 2 deaths in 84 cases, and that of Pouteau,³ 3 in 120, are apparently the best on record for lithotomy among the older records. It is a success to be aspired to, but rarely reached, although not quite as brilliant as it looks, since less than one-third of Martineau's patients had reached fifty years. Only eleven were over sixty, and both the deaths occurred among these eleven. Alan P. Smith⁴ has recently reported still better figures, 52 consecutive cases of lithotomy without a death, 7 of the patients being between 40 and 71 years of age.

Dudley, of Kentucky, is reported to have operated one hundred times consecutively without a death; but this evidence is not founded on personal, written notes. Cheselden,⁵ the father of the lateral operation, cut 213 times, averaging 1 death in 20 for all ages; a superb result, and showing only 1 death in 35 under the age of 10. The late S. D. Gross, of Philadelphia, cut, all told, 165 patients, with 14 deaths: 72 of these were children, with 2 deaths, 1 in 36; 93 adults gave 12 deaths, 1 in 7 $\frac{3}{4}$.⁶ Gross,⁷ out of 2303 American cases of lateral lithotomy at all ages, finds 156 deaths, 1 in 14 $\frac{3}{4}$. A collection by the same writer of 2711 European operations gives a mortality of 278, 1 in 9 $\frac{3}{4}$.

Gross's general table⁸ shows 13,570 operations at all ages, and by all cutting methods, with 1549 deaths, an average of 1 in 8.76. This would necessarily be a low average, since it includes all operators and all operations without selection, and pays no attention to the patient's age; but it must not be forgotten that many fatal cases fail to get recorded. It may be considered an excellent average if a general surgeon has a mortality no higher than 8 per cent. in his operations, 1 in 12 $\frac{1}{2}$ cases, without regard to age or selection.⁹ Morton's tables, showing the mortality of lithotomy in the Pennsylvania Hospital at the hands of all operators, over a period of 122 years, give 1 death in 7 cases.¹⁰

This method of reasoning by general statistics leads to a general conclusion, and has no value when applied to a special case or set of cases. Here the element of age comes in most prominently.

Thompson's table, in this respect, as establishing a general average of mortality for the various ages, is full of value. It has never been practically contradicted by an array of figures from varying sources of equal weight and authenticity, and it is to-day a reasonably fair standard by which any one

¹ See page 779, *infra*.

² Med.-Chirurg. Trans., vol. xi. p. 402. 1821.

³ Quoted by Gross, op. cit., 3d ed., p. 276. 1876.

⁴ Trans. of Med. and Chir. Faculty of Maryland, April, 1878. Reprint.

⁵ Cheselden's Anat., 5th ed., p. 322 *et seq.* 1740.

⁶ Am. Journ. Med. Sci., July, 1884, p. 305. ⁷ Op. cit., p. 275.

⁸ System of Surgery, 6th ed., vol. ii. p. 736. 1882.

⁹ A very recent table by Nishan Altonnian, of Turkey in Asia (Am. Journ. Med. Sci., July, 1883, p. 151), of 272 lithotomy operations, shows only 15 deaths, 1 in 18.13:—

Under 10 years,	.	.	.	.	.	.	.	.	.	47 cases, 1 death.
Between 10 and 20 years,	.	.	.	.	.	.	.	.	.	99 " 4 deaths.
" 20 " 30 "	.	.	.	.	.	.	.	.	.	66 " 2 "
" 30 " 40 "	.	.	.	.	.	.	.	.	.	38 " 2 "
" 40 " 50 "	.	.	.	.	.	.	.	.	.	23 " 4 "
" 50 " 60 "	.	.	.	.	.	.	.	.	.	6 " 0 "
" 60 " 80 "	.	.	.	.	.	.	.	.	.	3 " 2 "

¹⁰ Surgery in the Pennsylvania Hospital, p. 140. 1880.

may measure the grade of his own success in cutting for stone. The table includes 1827 cases furnished by a great number of operators:—

From 1-5 years	1 died out of (about) every	14 $\frac{1}{2}$
“ 6-11 “	1 “ “ “ “	23 $\frac{1}{2}$
“ 12-16 “	1 “ “ “ “	9 $\frac{1}{2}$
“ 17-20 “	1 “ “ “ “	7
“ 21-29 “	1 “ “ “ “	8
“ 30-38 “	1 “ “ “ “	10 $\frac{1}{2}$
“ 39-48 “	1 “ “ “ “	6
“ 49-58 “	1 “ “ “ “	4 $\frac{3}{4}$
“ 59-70 “	1 “ “ “ “	3 $\frac{3}{4}$
“ 71-81 “	1 “ “ “ “	3 $\frac{1}{6}$

This shows that the safest time to cut for stone is after babyhood and before puberty. Next in order comes the infant age—below 5. Puberty has a depressing influence. Mature manhood gives better results, and after sixty, about one patient in every three and a half dies if cut.

Coulson's¹ table (in decades) of 2972 cases furnished by Castara, Smith, Crosse, Cheselden, Dupuytren, and South, gives a somewhat similar result. I have arranged it so that it may be compared with Thompson's:—

Age.	Death rate. Coulson.	Thompson.	Death rate.
From 1-10 years	1 to 13.08	1 to about	18.91
“ 11-20 “	1 “ 10.28	1 “ “	8.25
“ 21-30 “	1 “ 6.61	1 “ “	4.00
“ 31-40 “	1 “ 5.83	1 “ “	10.50
“ 41-50 “	1 “ 4.50	1 “ “	6.00
“ 51-60 “	1 “ 3.65	1 “ “	4.75
“ 61-70 “	1 “ 3.23	1 “ “	3.75
“ 71-80 “	1 “ 2.71	1 “ “	3.16

These figures are undoubtedly good standards to go by. Much better results with children have been achieved by individuals, and even in general hospitals. And much worse results are recorded of brilliant operators, but, in the main, the average of these figures has gone unchallenged. They relate to the *lateral operation*.

The weight of the stone—other things being apparently equal—has a distinct bearing on the mortality of lithotomy, as shown by the very interesting tables compiled by Gross² from the 1327 cases of calculus tabulated by Crosse, of Norwich, and by Garden, of the Saharunpore Dispensary. When the stone weighed less than—

1 ounce there was	1 death in	11.01 cases.
between 1 and 2 ounces there was	1 “	6.55 “
“ 2 “ 3 “ “	1 “	2.72 “
“ 3 “ 4 “ “	1 “	1.75 “
“ 4 “ 5 “ “	1 “	1.83 “
“ 5 “ 6 “ “	1 “	3.50 “
“ 6 “ 7 “ “	1 “	1. “

Claims of superiority for one cutting operation over another have been made on the ground of facility of execution (high operation), anatomical reasons (median), safety (perineal lithotripsy), size of the stone (bilateral, vesico-rectal). Statistics of these operations—other than the lateral—are of only secondary importance.

The *high operation* is confessedly very fatal, although at present it is

¹ Op. cit., p. 523.

² Practical Treatise on Diseases, Injuries, and Malformations of Urinary Bladder, etc., p. 278.

growing in favor in this country, through the advocacy of Dulles, of Philadelphia, and in Germany and France under the influence of Petersen, Ultzmann, Albert, Dittel, Langenbuch, Guyon, Périer, Bouley, Monod, and others. The general mortality seems to be about one in three and a half (Dulles¹ gives 636 cases, 182 deaths, 1 in $3\frac{1}{2}$). Frère Côme had 100 cases and 19 deaths, 1 in 5.27, an excellent showing; but of these 59 were in females, with 9 deaths, 1 in 6.55, and 41 in males, of whom 10 died, 1 in 4.10. Souberbielle had 90 cases with 31 deaths, 1 in 2.90. Of his patients, 6 were under 20 years of age, and 2 died, 1 in 3. Therefore 30 per cent. of deaths is a fair average of mortality to accord to the operation as formerly practised, as far as statistics are a guide.

It can be shown that modern statistics under the very best circumstances are but little better. Individual sets of small numbers of cases are not important. My personal statistics are absolutely bad. At the date of my operating, several years ago, the total number of my operations by other methods had been thirty-eight, with one death. Then I operated three times in succession by the suprapubic method, and all my patients died. Two were desperate cases and would have terminated fatally, I believe, under any circumstances, but the other was an excellent case, and ought to have ended in recovery by any method. It was before the day of litholapaxy. The operation was not at all complicated, but the patient died with suppression of urine, high temperature, and uræmia, in two days. No autopsy was allowed. There was no evidence of local mischief, and death undoubtedly came by the kidneys. As against these unfavorable statements I deem it just to array a set of cases communicated to me by letter, the results of which are unsurpassed. Mr. A. Groves, of Fergus, Ontario, Canada, writes me that he has performed the high operation four times successfully.

CASE I.—Man of sixty-three years, weighing three-hundred pounds, who had been a very hard drinker; six stones removed. Five measured one and a quarter inch each in the longest diameter; the sixth, quarter of an inch.

CASE II.—Man sixty-seven years old, much debilitated, stone one and a half inch in diameter.

CASE III.—Boy six years old, mulberry calculus one inch in diameter.

CASE IV.—Man sixty-four years old, twenty-five calculi removed.

Truly a remarkable experience, and an excellent showing for the high operation.

Dulles's² statistical report, in April, 1878, gives a table of 20 cases as having occurred in the 10 years just preceding, with only two deaths, 1 in 10. But an analysis of the table shows that the average age of the patients was under 16 years, and that the two deaths were in infants of 4 and $2\frac{1}{2}$ years. Further, a foot-note says that two operations are left out of the computation because they were complicated by having had the lateral perineal operation done upon them at the same time with the high operation—yet another look at the table makes this reason hardly a good one, since it is observed that the table contains two successful cases in which this same double operation was done (Billroth's and Watson's), and a suspicion is excited that the two cases left out may perhaps have had a fatal issue, in which event the mortality would be 4 in 22 cases, 1 in $5\frac{1}{2}$.³

¹ Personal letter, and Gross's System of Surgery, 6th ed., vol. ii. p. 759.

² Am. Journ. Med. Sci., April, 1878, p. 394.

³ Replying to a letter, March 29, 1884, Dr. Dulles says that he has collected nearly 700 cases; but he does not mention the death-rate, referring to the figures in Gross's Surgery, 1 in $3\frac{1}{2}$, as his last utterance. He adds further, in explaining the construction to be put upon his table here referred to: "The two cases omitted were fatal. I omitted them because, while it is certainly right to credit the suprapubic method with success where it has been complicated with another

Finally, the very best operation scientifically, that now practised in France—the Petersen-Guyon-Périer operation, done antiseptically with drainage, etc.—shows according to Villeneuve,¹ in the 21 cases reported, a mortality of 30 per cent.—no better than that of the general table first constructed by Dulles, and including the figures of all operators. Guyon's² 8 operations yielded 3 deaths, 1 in 2.66. As a final contribution to statistics, I may cite the thesis of A. Garcin,³ of Strasbourg, 1884. He collates the published operations of suprapubic cystotomy during the years 1879–1883—modern operations—referring for statistics up to 1851 to Günther, and from 1851 to 1878 to Flury. Of the strictly modern operations, 94 were for the extraction of stone or foreign body from the bladder. Of these, 23 died, 24.40 per cent. as follows:—

Age.	No. of Cases.	Ratio.	Percentage of Mortality.
1–10	22	1 : 4.40	22.72
10–20	26	1 : 2.6	3.84
20–30	8	1 : 4	25.
30–50	7	1 : 7	14.28
50–70	16	1 : 2.28	43.75
70–90	11	1 : 2.75	36.36

This is perhaps the best general showing ever made for the operation—but it surely is not very encouraging, and a later exhibit by Tuffier, Guyon's mouthpiece, is a shade worse. He uses Garcin's figures, and adds more recent ones, making 120 operations with a mortality of 27 per cent., and says that in the 22 cases, all told, since 1879, in which suture of the vesical walls has been resorted to, the suture has failed 20 times.⁴

Since, however, this operation is often reserved for the most severe cases, its apparently bad showing does not possess all the significance it appears to have. This becomes more evident from a glance at the comparative results of the lateral and high operations when the weight of the stone is taken into consideration, as very clearly set forth in the following excellent table prepared by Gross.⁵

	Lateral operation.		Suprapubic operation.	
	No. of cases.	Rates of death.	No. of cases.	Rates of death.
Under 3j	529	1 in 11.25	14	1 in 4.66
3j–ij	119	1 “ 6.61	21	1 “ 5.25
3ij–iij	35	1 “ 2.18	14	1 “ 3.50
3iij–iv	11	1 “ 1.57	19	1 “ 3.16
3iv–v	5	1 “ 1.66	16	1 “ 2.28
3v–vj	2	1 “ 2.00	11	1 “ 2.75
3vj–vij	2	1 “ 1.00	2	1 “ 2.00

hazardous procedure, it is, equally, unjust to deduct from its credit any case where such complication was followed by death. The former is undoubtedly a recovery from the operation, the latter cannot be charged to either method.”

¹ Rev. de Chirurgie., Sept., 1883, p. 665.

² Ann. des Mal. des Org. Génito-Urinaires, Déc. 1882, et Janv. 1883.

³ Contribution clinique à l'étude de la cystotomie suspubienne, etc. Ann. des Mal. des Org. Génito-Urinaires, Juin, 1884, p. 360.

⁴ Certain foreign bodies are manifestly appropriate for removal by the high operation. Donnel Hughes (Phila. Med. Times, Dec. 15, 1883, p. 207) reports the successful removal of a steel bonnet-pin with a glass head. I find in the Philosophical Transactions (Abridged, 4th ed., 1731, Obs. 83, p. 162), the record of an amusing as well as instructive case. One Dorcas Blake, in 1694, was cut by Mr. Proby above the pubis to extract an ivory bodkin, four inches long. He cut outside the rectus muscle, and, as he very candidly confesses, “by God's great blessing, she was perfectly cured.” The interest in this case is increased by the fact that this “full-bodied, sanguine maid, about 20 years old” went before the Lord Mayor, June 10, 1695, and swore that she had swallowed the bodkin; and her doctor believed her, although her vesical symptoms had appeared within a very suspiciously short time after the alleged swallowing.

⁵ Op. cit., p. 296.

This table clearly goes to show that the larger the stone, the safer relatively to the lateral section is the high operation. But it shows with still greater force and clearness that *the high operation is not applicable to stones under one ounce in weight* (and the majority of stones found in practice weigh less than one ounce), since the mortality of such stones is nearly three times greater for the suprapubic than for the lateral operation.

This criticism is enforced by the unimpassioned eloquence of Billroth, a general surgeon, and therefore a most competent observer and critic, who in speaking of the operation remarks :¹—

This operation finds no great favor with me, although formerly when I was fortunate enough to be Von Langenbeck's clinical assistant, I was very much taken with it, and it appeared to me to be the ideal of an operation for stone. The cases of suprapubic operation in children performed by Von Langenbeck's masterly hand, did well eventually, but there was much sloughing of the cellular tissue in the neighborhood of the wound. After the slough separated the wound granulated up well and closed rapidly, but the children always were very ill after the operation, and suffered far more than when subjected to median or lateral lithotomy.

My conclusion from the evidence, therefore, is that the high operation is suitable for the management of very large stones, for encysted stones, for stones complicated by tumors of the bladder, and for certain foreign bodies, but that it is not appropriate for general application.

The claims of the *median operation* have been advocated in this country by Markoe and others, and the operation has been rather more favored in some quarters than the lateral section.

Its statistical showing has also been very good, particularly in this country, but as the operation has been employed mainly with children, and in cases of small stone, these results do not prove its value as a general procedure. The excellent analytical table of C. Williams,² of 64 cases operated on at the Norfolk and Norwich Hospital, sets forth these facts quite clearly; for of these operations, those done under the age of 40 showed a mortality of 1 in 14, and of the remainder, done between 40 and 80, the deaths were 1 in $3\frac{3}{11}$, while where the stone weighed over 3 drachms 2 scruples, only one recovery took place—a very large stone of $4\frac{1}{2}$ ounces—and in this instance a portion of the perineum and rectum sloughed, and a permanent perineo-recto-vesical fistula was established.

Williams compares these 64 cases with the last 64 lateral lithotomies done in the same hospital—the mortality in the latter being 8, against 13 deaths in the same number of median sections. This showing, so favorable to lateral lithotomy, should be modified by saying that the average age in the patients submitted to lateral lithotomy was something under 38, while the age of those undergoing the median section averaged something under 45.

The *bilateral* and *recto-vesical* manœuvres are modifications of the lateral and median operations. The former is often appropriate, the latter never. Even in its best showing—Kœnig's table—the mortality is 1 in 5.18 (ages not given), and fistula remained in those who got well in 1 case out of each 6.

LITHOTRITY.—The statistics of lithotritry belong to two groups, one representing the old, the other the modern operation.

Statistics of the former are well known, of the latter not yet fully made up. A collection of lithotritry operations, 1470 in number, by various surgeons, has been made by Gross,³ with a mortality of 1 in 9.24. In children, out of 21

¹ Clinical Surgery, New Sydenham Society's Translation, p. 276. London, 1881.

² Holmes's System of Surgery, 2d ed., vol. iv. p. 1078.

³ System of Surgery, 6th ed., vol. ii. p. 736. 1882.

cases collected by Guersant, 6 terminated fatally, and 62 operations upon children in the Moscow Clinique furnished also 6 deaths—a very bad showing for calculus in the child.

Gross's table relates to the old operation, and the figures have at best a very vague significance, for all ages are included, and the cases were often selected. The fact of selection has greatly enhanced the apparent value of lithotripsy. Thus Keith and Fergusson in 231 cases of lithotripsy lost 21, a death-rate of 1 in 11.55, while out of 296 lithotomies, the same surgeons lost 75, or 1 in 3.94. Again, Gross has compared the results published at date of the lithotrities of Thompson, Brodie, Fergusson, and Keith—637 cases in adult males, with 46 deaths, 1 in 13.84—with the results of lateral lithotomy by various surgeons taken from Thompson's table and covering the same period of life, 723 cases with a death-rate of 1 in 4.82.

While selection of cases may here be accredited with a measure of the success, still the showing is admirable for the old operation of lithotripsy in adults.

Coming down to special statistics, Fergusson lost 1 in 9.08; Brodie 1 in 12.77; Heurteloup claimed to have lost only 3 out of 69 cases—1 in 23—and he operated at a single sitting;¹ Keith² 1 in 18.42. Civiale's well-known statistics claimed a mortality of only 1 in 41.50. But it is well known that he abandoned the operation in ten patients who died, and these, being added, bring his mortality up to 1 in 24, a result certainly good enough to be satisfied with. But the Necker Hospital statistics of Civiale, are those upon which most reliance can be placed, since they were kept by individuals unfriendly to the great lithotritist; and these give³ for 78 cases 5 deaths, a rate of 1 in 15.60. Thompson's⁴ latest figures are 422 lithotrities with a death-rate of 1 in 13; Cadge⁵ reports 86 lithotrities with a death-rate of 1 in 10.75. Ivanchich,⁶ in Germany, has done very well for the old operation. Out of 300 cases of short sittings, under ether when necessary, he lost in the first hundred 14, in the second hundred 5, in the third hundred 3—in all 22, or about 7 per cent.—the last hundred giving the best showing ever made for old-fashioned lithotripsy.

The present showing of litholapaxy is better than this. The operation is in full course of experiment all over the world, and no figures now given will be accurate a few years hence.

Some efforts have been made to collect material from which to generalize:—

Bigelow's announcement of the method appeared in January, 1878.⁷ Up to Feb. 15, 1880, I had collected⁸ 120 cases at the hands of all operators, with 6 deaths, a mortality of 1 in 20. In November, 1880, the number had only reached 162.⁹ Of these, 125 had been operated upon by surgeons who had recorded five or more operations, and might be presumed to be fairly skilful in vesical surgery. The mortality was 5—1 in 25. The remaining 37 operations had been done by surgeons having recorded less than five cases, and among these there were six deaths—1 in 6.16. Gross,¹⁰ in 1882, reported for all operators 312, with 17 deaths—1 in 18.35. Guyon's collection of 590 operations gives 36 deaths—1 in 13.61. (Desnos.) Bigelow's personal statistics up to July, 1884, include 77 cases, of which five were fatal—1 in 15.4, about 6 per cent. In three cases

¹ De la Lithotripsie sans Fragments, etc. Paris, 1847.

² Brit Med. Journ., March 20, 1869.

³ Traité de la Lithotritie, p. 567. Paris, 1847.

⁴ Lancet, March 16, 1878, p. 385.

⁵ Ibid.

⁶ Mein Epilog, achter Sammelbericht von 33 Fallen von Lithotripsie zur Ergänzung meiner Kasuistik auf die Zahl 300, u. s. w. Wien, 1881.

⁷ Am. Journal Med. Sciences.

⁸ Annals of the Anatomical and Surgical Society, vol. ii. No. 6. 1880.

⁹ Holmes's System of Surgery. American reprint, vol. ii. p. 885. 1881.

¹⁰ System of Surgery, 6th ed., vol. ii. p. 736.

there was an autopsy, showing that a damaged kidney was the cause in two instances. In the other no cause was evident. In the fourth case, pyelitis was undoubtedly the cause of death, though there was no autopsy. In the fifth the cause was not clear. One patient died a month after the operation, and, as Bigelow remarks, the fact is simply that his operation did not save him from impending death by renal disease.

The two largest stones thus dealt with have been one of 1802 grains—removed successfully in three sittings, and one of 1380 grains, in one sitting of one hour and fifty-five minutes, also a success. Thompson's figures, when recorded for his first hundred and odd cases, showed a mortality of about three per cent. In response to a letter asking for statistics in the spring of 1884, he kindly sent me a digest of his sixth lecture delivered before the Royal College of Surgeons, in June, 1884. In it he deals with the whole subject collectively, giving his statistics from 1860 to 1884. At that time he had performed litholapaxy 191 times, but he does not mention the exact mortality. His general showing is admirable for all operations, 807 operations on 715 individuals. Of these 13 were females, with 1 death; 15 were children, with 1 death; 775 were adult males. Of the latter, 110 were cut, with 39 deaths—1 in almost 3—about 35 per cent.; 665 were operated on by lithotrity, the old and the new operation included, with 43 deaths—1 in 15.5, or under $6\frac{1}{2}$ per cent. Of this total, 775 adult male cases, the death-rate, all told, was 1 in 9.5—and 591 of the patients were upwards of 50 years old. He states further that, in his entire experience, he has refused operation to 6 patients only. This is certainly a remarkable record. Of his last 116 lithotrity operations (litholapaxy), 6 ended fatally—1 in 29 cases, or less than $3\frac{1}{2}$ per cent.

G. Buckston Browne reports to me by letter, that, up to May 8, 1884, he had operated by the new method 48 times with 2 deaths, both in old men, who died uræmic, probably with surgical kidney. Caswell, of Providence, has a small, but perfect record of successful operations for small stones upon ten individuals consecutively, and Chismore, of San Francisco, makes me a similar report orally, having operated upon eleven cases without a death. Dittel¹ adds 50 new cases in 1884, to a former report of 30 cases, the whole yielding him 5 deaths—1 in 16—about a mortality of 6 per cent. Dr. L. A. Stimson, of this city, reports to me a list of eleven successive and successful cases.

My own statistics² are briefly these: Total number of operations 52, with 3 deaths. My first 17 consecutive cases were successful; the 18th patient died, after a second sitting, from advanced pyelitis. He had been bed-ridden a year—and, as in Professor Bigelow's case, the operation failed to save him from the natural result of advanced degenerative disease of the kidney. My second death was also due to renal complications—suppression, high fever, uræmia. There was no autopsy. The kidneys were known to be diseased before the operation. The third death can hardly be charged to the operation. The subject was an old hospital patient, a man of 80 years, bed-ridden, with large prostate, chronic cystitis, and damaged kidneys. A small phosphatic accumulation (about half a drachm) was discovered, and removed in less than fifteen minutes. The patient's symptoms became aggravated and he died in a week. My general impression is that the operation is reasonably (but not entirely) safe, even where the kidneys are unsound, and that with perfectly healthy kidneys litholapaxy properly performed is nearly as harmless an operation as passing a catheter.

My collection contains one oxalate-of-lime stone, weighing an ounce, and removed in 32 minutes; a phosphatic stone weighing 765 grains, and removed in 45 minutes; an acid stone weighing 1065 grains removed in one hour and fifteen minutes; each of these at one sitting, and all successfully.

Guyon's statistics are recorded in the thesis of E. Desnos. They comprise 226 cases with 12 deaths. Still more recently, Kirmisson,³ another of Guyon's pupils, has brought the record up to 1883, adding Guyon's last 70 cases, with 2 deaths. This clearly puts the number of Guyon's operations at the top of the list. He has operated 296 times with 14 deaths, 1 in 21.13, or less than 5 per cent. of mortality, a most

¹ Wien. med. Wochenschrift, Nos. 3–11, 1884.

² In some of my earlier cases Dr. Van Buren did a part of the crushing. He approved the operation heartily, but his failing health prevented him from operating often, and the active work in most of the cases fell naturally to me.

³ Des Modifications modernes de la Lithotrité, p. 67. Paris, 1883.

admirable showing. P. J. Freyer,¹ an East Indian surgeon, reports 111 cases and 4 deaths, 1 in 27.75—a mortality of less than 4 per cent—which places him at the head of the list of successful operators who have had over 50 cases.

The two operations have been compared on four occasions. The Vienna General Hospital for the year 1881 reported :—

Lithotritry 14 cases	.	.	.	.	.	.	1 death
Litholapaxy 22 “	.	.	.	.	.	.	0 “

Thompson, in the sixth edition of his *Diseases of the Urinary Organs*, reports 112 consecutive cases of rapid lithotritry performed upon elderly men averaging over 62½ years, with 3 deaths, 1 in 37.33. He says that by the old operation his mortality was 7.50 per cent., or 1 in 13.33, and that in his best series of 112 cases he had 6 deaths. In the hands of this able operator, therefore, the new operation has yielded results exactly twice as good as those obtained by the old method.

Billroth,² in a paper read before the Vienna Medical Society in 1880, speaks of 41 patients operated upon by himself by old lithotritry; of these, 9 died, seven after the first sitting, two after the second. He had done litholapaxy 7 times with one death, which he ascribed to poisoning by chlorate of potassium. The patient had taken 620 to 700 grains a day.

Guyon, reporting through E. Desnos³ in a thesis referred to in the *Revue de Chirurgie*, says that he has practised old-fashioned lithotritry in 73 cases, with 6 deaths, 1 in 12.16; as already mentioned, his modern operations have been 296 in number, with 14 deaths, 1 in 21.14.

RELAPSE AFTER RADICAL TREATMENT.

The question of the number of cases of relapse occurring after radical treatment, deserves consideration in connection with other statistical arguments bearing upon a choice of the method of cure. Mr. Charles Williams, of the Norfolk and Norwich Hospital, has studied this subject very thoroughly. His latest utterance appeared in 1878,⁴ and may be taken to represent the state of the case now, as far as concerns old-fashioned lithotritry and lithotomy. The question of relapse after litholapaxy has not yet been made the subject of generalization.

Mr. Williams says that during a period of 97 years, in 935 lithotomies (lateral and median), relapse occurred once in every 33 cases. The recurring stone was not always of the same composition as the calculus which had been removed by the first operation.

In 19 instances the second stone was like the first—10 phosphatic, 9 uric-acid and urate. In 7, phosphates followed urates; in 2, phosphates followed oxalates. This seems to show that there were only 9 cases of true relapse of acid primary stone, for a reproduction of phosphates is simply the return of a physical symptom of a morbid condition (chronic catarrhal inflammation), and as that morbid condition is not necessarily removed by the operation, so the recurring stone may be a relapse not in any possible way dependent on the character of the operation. Where secondary follows primary stone, it is fair to believe that the operation may be at fault in having lighted up a catarrhal inflammation which has become chronic, or in having left a fragment behind. A new nucleus also, in any case, may come down from the kidney after the operation.

From the records of the Charité Hospital, in Paris, it appears that the pro-

¹ *Lancet*, February 28, 1885, p. 378.

² *Wiener med. Wochenschrift*, Nos. 44 und 45, 1880.

³ *Rev. de Chirurgie*, No. 12, 1882, p. 992.

⁴ *Lancet*, May 18, 1878.

portion of relapses after lithotomy was 1 in 11. Civiale, in collecting statistics found for lithotomy in Bavaria 1 relapse in 32 cases, in Bohemia 1 in 56, in Dalmatia 1 in 53. At the Luneville Hospital, the registration of 1592 operations showed 13 relapses, 1 in about 123—Civiale¹ puts it wrongly 1 in 116—and Civiale's² general collection of 4446 lithotomies allows 42 relapses—1 in about 105%.

Against this may be placed the proportion of relapses confessed to have occurred in their own operations (the old one), by the two great lithotritists Thompson and Civiale. The former noted relapse in one of twelve cases, the latter in one of ten.

Hence there can be no reasonable doubt that relapse is far more common after old-fashioned lithotritry than after lithotomy, and this conclusion is supported by inductive reasoning. For the causes of relapse after operation are three: (1) a new renal nucleus; (2) a piece of stone left behind to form a nucleus for the new calculus; (3) damage done by the operation, leaving a catarrhal surface in the bladder which leads to the deposit of secondary (phosphatic) stone. The first of these causes exists equally under all operative circumstances, but in the second and third cases undoubtedly, if the fault exists in the operation, old-fashioned lithotritry must be more exposed to it than lithotomy.

This is not true of modern lithotritry. Phosphatic re-accumulations occur frequently after this operation, but not often because of it. They will be equally frequent whatever is done, if only the causes of secondary stone persist (prostatic hypertrophy, vesical atony, chronic cystitis, etc.). But litholapaxy offers so many advantages in its mechanical execution for detecting and removing a last fragment, that relapse from a neglected fragment after this operation must be ascribed rather to the operator than to the method.

Kirmisson, who in his study of Guyon's 296 operations by the new method has had the best opportunity of speaking authoritatively, says³ that there have been only 9 cases of relapse noted out of the whole number, and he adds that, if phosphatic re-accumulation be left out of the question, a permanent cure may be always expected.

CHOICE OF OPERATION.

Apart from statistics and the question of relapse, a practical consideration of the question of a selection of a method of cure in a given case requires investigation both as to (1) the peculiarities of the patient, and (2) the peculiarities of the stone.

I. THE PECULIARITIES OF THE PATIENT, as influencing a choice of operation for the cure of stone, are (1) age; (2) the state of the general health; (3) the local condition of the genito-urinary tract.

(1) *Age*.—In the male, before puberty, statistics teach that the cutting operation has heretofore given by far the best results, though litholapaxy is yet on trial. In 1881, two cases were operated on by litholapaxy in Germany:⁴ Billroth operated once on a boy of six; some fragments were left, and infiltration and death followed. Dittel operated on the other case, but failed, and had to resort to lithotomy. Guyon⁵ was successful once with an infant of four years, upon whom a No. 16 (French scale) tube was used, and Keegan⁶

¹ Op. cit., p. 695.

³ Loc. cit., p. 70.

⁵ Indian Medical Gazette, May, 1884.

² Ibid.

⁴ Allg. Wien. med. Zeitung, 29 Nov. 1881.

⁶ Rev. de Chirurgie, No. 12, 1882, p. 992.

recently has reported 24 lithotrities in male children. In 7 no tube was used. In the 17 litholapaxies, the patient's age in one was 20 months, in one 2 years, in one 3, in one 4, in five 5, in two 7, in three 8, in one 10, in one 12. These 16 patients recovered. The seventeenth was subjected to three sittings, and died. Small instruments were used, and the time of the operations varied from 4 to 70 minutes.

Such success leaves little to desire, but until more numerous operations are tabulated at the hands of many operators, it will be more prudent for the general surgeon to cut male children before puberty than to attempt litholapaxy.

As to what cutting operation shall be adopted in the child, the advocates of the median and lateral operations both claim the field, but the statistics of the lateral are better than those of the median, particularly for large stones. When the stone is quite small and the bladder not much inflamed, for anatomical reasons the median section is perhaps preferable.

Female children of whatever age may be treated by litholapaxy. The urethra may be dilated, and the straight or curved tube used. I have operated once, upon a girl of four years, with ease and success.

In the male after puberty, until the most remote period of life, there is nothing in the age of the individual which contraindicates litholapaxy, while the mortality under lithotomy is shown by all tables to increase steadily with the patient's age.

(2) *The State of the General Health.*—In case of general disease, it becomes often a serious matter to decide whether to subject the patient to any radical operation, or simply to use palliative measures. No rules can be laid down. The surgeon's general knowledge and experience must guide him. Some distinctions, however, may be made. Thus in diabetes, lithotrity might be justified where lithotomy would be out of the question.

In Bright's disease it may be difficult to make a choice. The existence of moderate, chronic, organic changes in the secreting portion of the kidney does not contraindicate operations upon the bladder, although it somewhat affects prognosis. Advanced renal disease of any kind increases the risk of all operations.

(3) *Local Condition of the Genito-urinary Tract.*—Such conditions are diseased states of the kidney, the bladder, or the urethra. Chronic pyelitis, with dilatation of the ureter and pelvis of the kidney, and with more or less of the accompanying interstitial changes in the secreting substance of the kidney, has the gravest influence in operations upon the urethra and bladder. Moreover, it is a condition not uncommon as a complication of some of the maladies which give rise to stone (prostatic hypertrophy, urethral stricture), and worse than all, it is a malady which often cannot be accurately diagnosed. Thompson has devoted a chapter to this subject, recognizing its paramount importance, and the difficulty, often the impossibility, of diagnosis.

This condition may be assumed to exist when the general health is poor, the mouth dry, the tongue pasty; when the pus in the urine is more thick and greasy than usual, and settles into a dense solid layer at the bottom of the vessel; when the specific gravity of the urine is light and its quantity not very great; and when there seems to be more albumen in the urine than the pus will account for. Such assumption of organic kidney changes may be made even if there are no casts in the urine, and no pain upon pressure in the region of the kidney, or along the ureter on either side.

When the last-mentioned set of symptoms exist; the diagnosis becomes nearly certain; but in the absence of all of them, kidney changes cannot be said to be absent in any case of prolonged chronic cystitis in a patient

beyond middle life, for they may be present without any especial distinguishing signs, the urine having only those qualities that belong to the urine of chronic cystitis.

When, therefore, chronic pyelitis is present, what is to be done? Such a complication does not absolutely contraindicate an operation upon the bladder, but it calls for special care in the preparation of the patient, and in the conduct of the operation. These are the cases which furnish the bad attacks of urinary fever after operation, and that desperately fatal sequence known as surgical kidney. Fortunately, however, all cases of chronic pyelitis do not yield serious complications after an operation upon the bladder. I believe that the following case is conclusive in bearing out this statement:—

A gentleman of 57, with vesical calculus, was brought from Massachusetts by Dr. Paddock, of Pittsfield, to Dr. Van Buren and myself. I operated upon him Dec. 11, 1878, by litholapaxy, removing two and a half drachms of stone, phosphatic about a uric-acid nucleus. No chill, no accident whatsoever marred a prompt recovery, and the patient returned home after a few days. He came back in three months for confirmation of his cure, and a search proved the bladder to be empty. He continued, however, to have occasional attacks of vesical irritability, with pain in the side, especially after exertion, and to pass a little pus with his urine; for he had vesical atony and eight ounces of residual urine which he could only void through a catheter; but his general condition was excellent, he took long walks over the hills, trout-fishing, and was delighted with the result of his operation, although he was never quite well.

On Dec. 8, 1880, three years after the operation, he died. Dr. Paddock wrote . . . "He seemed in his usual health until the evening of Dec. 1, when he had an attack of renal colic. The pain was relieved in a few hours by an anodyne powder. He had a severe chill on the morning of Dec. 3, followed by pain in the back, with scanty urine containing blood, rapid and weak pulse, quick respiration, and gradually increasing cerebral symptoms. He died comatose on the afternoon of Dec. 8. At the autopsy, the right kidney was found entirely degenerated, one-half of the capsule being occupied by a cyst containing an ounce and a half of fluid, the other half by simply fibrous tissue. The left kidney was double the natural size, intensely congested, its surface covered with ecchymotic spots, some of them as large as a nickel cent, the pelvis and tubules distended with bloody urine, and the upper end of the ureter plugged with a mulberry calculus." The bladder was dilated, with thinned walls. It contained no stone, and the prostate was not enlarged.

This case is very instructive. There were at the time of the operation vesical atony, eight ounces of residual urine, vesical catarrh, and phosphatic stone—yet three years afterwards, at the autopsy, the prostate was not found to be hypertrophied. Hence it is plain that the vesical symptoms were reflex in origin, and due to disease above, undoubtedly to the degeneration of the right kidney. No accident attended the operation, and the patient did well until a new stone of oxalate of lime formed in his left kidney; this stone, by plugging the only remaining duct for urinary excretion, promptly terminated his life. Although kidney disease be detected, still an operation may be undertaken. Of the three methods, a choice may fairly be made in favor of litholapaxy, unless there is something in the condition of the bladder, prostate, urethra, or stone, to call for lithotomy.

The objections to old-fashioned lithotripsy are the necessary number of sittings, each one of which involves a separate risk, and the especial danger of exciting acute cystitis by the large, sharp fragments left after the first sitting. The well-known fatality of lithotomy in late life, is probably largely due to the renal complications which so often attend chronic cystitis at that period.

The morbid conditions of the bladder and prostate which influence a choice of the radical operation for stone, are chronic cystitis and tumors of the bladder and prostate. Acute cystitis need not be considered. Although one of the

periods of exacerbation of cystitis which usually accompany stone is not a favorable one for operation, yet either lithotomy or litholapaxy may be performed during its existence, with the happiest result.

A rule of old-fashioned lithotrity proves this, for when a given sitting was followed by severe acute cystitis, it was considered good practice to perform lithotomy at once, and thus relieve the bladder of its torment.

Litholapaxy has in view the avoidance of cystitis by attempting to clear the bladder of all fragments at a single sitting; but some years before litholapaxy was invented, Thompson declared that the acute cystitis following a sitting of lithotrity was one of its chief dangers, and proposed, and successfully practised as a cure for acute cystitis complicating lithotrity, a new, long sitting under ether, in which an attempt was made to rid the bladder of all foreign matter. This expedient, although not identical with lithotomy for the same complication, was equivalent in its object and in its effect.

Chronic cystitis of high grade and unusual severity clearly calls for lithotomy—lateral lithotomy—that the bladder may be thoroughly drained and left at rest after the operation. Cystotomy under such circumstances deals with two maladies at once, and the greater risk of lithotomy is more than compensated by the prospect of curing the cystitis, while the danger of acutely aggravating the severe chronic cystitis by the necessarily harsh manœuvres of litholapaxy, makes the latter operation a second choice.

In like manner, if a tumor of the bladder complicates stone, lithotomy is called for, that both maladies may be treated at once. Benign tumors of the prostate belong to the same category; but only when they interfere with the passage of the urine, and are not complicated by atony of the bladder. For if there is atony of the bladder, and the patient is obliged to use a catheter habitually, he gains nothing by cystotomy, and incurs a greater risk to be rid of his stone by reason of the greater gravity of lithotomy in advanced age as compared with lithotrity. When, on the other hand, the expulsive power of the bladder is strong, notwithstanding the prostatic obstruction, then cystotomy is preferable, for the interstitial prostatic tumor may be taken out at the time of the operation; or the outstanding prostatic growth (third lobe or lateral overgrowth) may be cut or twisted away, thus restoring to the patient the lost function of urination. I have operated upon one such patient, who, before the operation, had not urinated for four years, except through a catheter. After the operation the flow occurred naturally. In another case I had a similar, though less brilliant, result. When the prostate is very long and rigid, and the lithotrite and tube pass with considerable difficulty, the risk of damaging the deep urethra may occasionally be so great as to justify a choice of lithotomy.

As far as the *urethra* is concerned, most obstacles to the free passage of large instruments may be overcome by preparatory treatment, or as a part of the final operation; but serious organic stricture of the deep urethra is a complication which justifies lithotomy—preferably the median or the medio-lateral operation—that the stricture may be dealt with by perineal section as a first step in the lithotomy operation. Dolbeau's perineal lithotrity is also applicable to these cases.

II. PECULIARITIES OF THE STONE AS INFLUENCING A CHOICE OF OPERATION FOR RADICAL CURE.—The stone itself influences the choice of operation only by its size or by its position in the bladder. A very small stone, but one too large to be washed out through a tube with the washing bottle, is suitable for old-fashioned lithotrity, without ether. The number of stones does not influence the choice of operation in any way: it simplifies rapid lithotrity, and very much lessens the danger of lithotomy, relatively to the total size

of the calculous mass. Nor does the composition of the stone enter into the question, excepting only in the case of oxalate of lime. An oxalate-of-lime stone, if quite large, may successfully resist the lithotrite. I was present at an operation upon a stone of this sort, in which the handle of the lithotrite broke, and the patient was thereupon successfully cut. But an oxalate-of-lime stone, one inch in diameter, may be very readily crushed. I have one such stone in my collection, weighing an ounce, removed in thirty-two minutes.

A stone may, however, have for a nucleus some foreign body which cannot be properly dealt with by lithotritry, such as a bit of wax, a glass tube, a piece of lead or iron (from gunshot wound), or a bit of silver catheter. I saw a piece of wax removed by Dr. George A. Peters through a Bigelow tube, and I have crushed and removed by the washing bottle a piece of soft rubber catheter which had formed the nucleus of a phosphatic stone.

But a stone may be so large that it cannot be grasped by the lithotrite, or it may be small enough to be grasped, and yet, being composed of oxalate of lime, it may fail to break. Then plainly lithotomy is the alternative.

Again, a stone may be lodged in some out-of-the-way pouch, as in a hernia of the bladder, or may be encysted and inaccessible to the lithotrite. Here the choice is palliation or lithotomy.

If the foregoing line of argument be correct, it is fair to conclude that to lithotomy must be given—

1. All male children before puberty.
2. All cases complicated by very severe, chronic cystitis.
3. Cases of tumor of the bladder complicating stone.
4. Some cases of prostatic overgrowth, not complicated with atony.
5. Some cases of very large prostate through which instruments cannot readily be made to pass.
6. Cases complicated by severe, deep, urethral stricture.
7. Cases of very large or very hard stone.
8. Cases of encysted stone.
9. Cases of certain foreign bodies.

All other patients who are proper subjects for radical operation may be best dealt with by lithotritry—very small stones possibly by the old-fashioned operation without ether, perhaps with cocaine, but all other calculi by litholapaxy.

CAUSES OF DEATH AFTER LITHOTOMY AND LITHOTRITY.

These are shock, hemorrhage, urinary fever, exhaustion, peritonitis, pyæmia, septicæmia, surgical kidney, and tetanus, and will be considered hereafter under the head of complications.

Shock is an uncommon cause of death. In lithotomy the size of the wound is small, the duration of the operation is brief, and no important organs or tissues are invaded. Hemorrhage, formerly more dreaded than other complications, is rarely fatal with the means now at the surgeon's hand, notably the rubber-tampon. Urinary fever may be somewhat guarded against by preparatory treatment. Exhaustion can hardly prove fatal except in a patient with unhealthy organs. Peritonitis, except as accompanying cellulitis, is rare. It is more common in children than in adults, and has been noticed after lithotritry. Pyæmia, septicæmia, and surgical kidney, are the most common causes of death after lithotomy or lithotritry, the first two usually as an accompaniment of cellulitis, caused often by bruising or lacerating the soft parts while extracting a large stone, particularly if the urine be putrid, by infiltration of urine, burrowing abscess, etc. Surgical kidney

is a sequence of an ascending inflammatory process, starting as an acute cystitis and terminating as an acute pyelitis, with multiple (bacterial) abscesses in the kidney—the whole culminating in death during coma, with high temperature and suppression of urine.

Pyæmia and septicæmia may be somewhat guarded against by preparatory treatment, directed toward depriving the urine of its putridity and ammoniacal qualities. Surgical kidney cannot be guarded against; it is more than anything else a result of a previously diseased condition of the kidney, and when it occurs it is the most certainly fatal of all the complications of operations upon the bladder. An occasional death by tetanus has been noted after lithotomy.

PREPARATION OF PATIENT FOR RADICAL TREATMENT OF STONE.

If a patient is young, with sound kidneys, a small stone, and a bladder reasonably free from inflammation, the urine being acid, no preparatory treatment is absolutely necessary, and an operation, well executed, is not much more likely to injure him seriously than it would after prolonged preparatory treatment. But the older the patient, the more damaged his organs, the higher the grade of the chronic cystitis, the more ammoniated and putrid the urine, and the larger the stone, by so much the more are skill, time, and attention needed in the preparatory treatment.

This should in the main be the same, whether lithotomy or lithotripsy be contemplated. It may be divided into two parts: (1) The general preparation of the patient. (2) The special preparation just before the operation, to be repeated in lithotripsy before each subsequent sitting.

(1) *General Preparation of the Patient.*—This consists in attention to the general health, to the condition of the urine, and to the state of the bladder and urethra. The general health may be fortified, if need be, by tonics, the bowels regulated, the diet looked into. As to diet, it is well to encourage the use of milk, both because it is very nutritive and acts as a mild soothing diuretic, and because it is an appropriate article of diet after the operation, and it is well to accustom the patient's stomach to its digestion and assimilation; when ordinary milk does not agree with him, peptonized milk, kumyss, or buttermilk, may be advantageously substituted.

The urine needs careful attention, first to decide whether kidney disease or diabetes exist, and, if so, whether any operation is allowable; and, secondly, as to its alkalinity and putridity.

It has been perfectly well established (Girard,¹ Malherbe,² Gosselin and A. Robin,³ Menzel,⁴ and Muron⁵) that normal urine—urine alkaline with fixed alkalies or acid with urates⁶—does not harm the tissues or occasion local inflammation, while urine in ammoniacal degeneration is deadly to tissue vitality. The more putrid and decomposed such urine, the more virulent does it become (swarming as it is with bacteria), and it is not wise to operate upon a bladder containing urine in this condition by the crushing operation, or, if it can be avoided, even by lithotomy. The causes of this putridity in the urine are chronic vesical catarrh, with atony, and the constant presence of residual urine in the bladder. Any grade of acute or chronic vesical catarrh

¹ Résorption urinaire et urémie dans les maladies des voies urinaires. Paris, 1873.

² De la fièvre dans les maladies des voies urinaires, Thèse. Paris, 1872.

³ L'urine ammoniacale et la fièvre urinaire. Paris, 1874.

⁴ Wien. med. Wochenschrift, Nos. 81–85. 1869.

⁵ Pathogénie de l'infiltration de l'urine. Paris, 1872.

⁶ Van Buren and Keyes, Genito-Urinary Diseases, etc., pp. 46, 144. 1874.

may exist with pus, blood, and even stringy mucus and ammonia in the urine, but positive putridity is only found where such urine is retained for some time in a paralyzed or atonied bladder.

Moderate putridity may be noticed occasionally in connection with long standing chronic pyelitis, with distended pelvis of the kidney, but such cases are not suitable for any radical operation for stone in the bladder.

When, therefore, the urine is putrid, preparatory treatment is imperative. The patient should be put to bed, the urine should be rendered dilute and abundant, and the bladder should be washed out with some warm antiseptic solution, the strength being meantime maintained by quinine, tonics, and a suitable diet in which, if possible, milk should form a part.

As diluents, the infusions, extracts, and decoctions of various vegetables (buchu, *triticum repens*, *pareira brava*, corn-silk, flaxseed) are of very little value, and gum and elm-bark water of none whatever. Buttermilk among the foods, and benzoic acid, the benzoates, salicylates, and salicine among the medicines, will effect what little is possible by ordinary therapeutic means.

But the stomach objects to the benzoates and often to the salicylates, and the best medical treatment by the mouth will usually be found to consist in a judicious exhibition of some diluent water. Simple rain-water—better if filtered—is generally effective, and this or any other water, when used as a diluent, should be consumed abundantly. Bethesda water (Dunbar's Spring), Poland water, Glen Summit, Clysmic, Mountain Valley (Arkansas), Wildungen—these are types of the waters which are most suitable, being bland diuretics, easily assimilated, and not owing their value to any especial mineral ingredient. They are little better than rain-water, and if stale are not as good, but they are easier to obtain in large cities, and are more readily assimilated by some stomachs.

Direct treatment by injection is more efficacious than any other means. As these patients with putrid urine usually suffer from vesical atony or paralysis, the catheter may be already in use. If not, the practice of drawing off the urine must be instituted with all the customary precautions, such as not emptying the bladder entirely at the first sitting, etc. Water at a temperature of about 100° F., and containing a tablespoonful or more of borax to the pint, may be injected through a soft catheter, preferably with a fountain syringe. The French use habitually a four-per-cent. solution of boracic acid. A double-current catheter should not be used. A bladder cannot be well washed unless it is moderately distended, so that its folds may be obliterated, and such distention is not effected by the double-current catheter. Mild solutions of permanganate of potassium may be used, or a one-per-cent. solution of carbolic acid. Two-per-cent. solutions, as well as all corrosive-sublimate solutions, have proved irritating in my hands. Dilute lead-water; mild solutions of sulphate of zinc, from three to ten grains to the pint; of nitrate of silver, half a grain to the ounce, slowly increased in strength; or other similar solutions, may be used. An excellent injection is the dilute nitric acid, from one to sixty minims in the pint of water. Borax and nitric acid have given better results in my hands than the other injections mentioned.

If the urine is not putrid, and in any case where there is no atony and no residual urine, it is doubtful whether vesical injections do any good. Yet often under these circumstances the bladder is highly inflamed, and manifestly not ready to be interfered with. The urine is full of blood, pus, or stringy mucus, and perhaps fever runs high. Such conditions are to be treated as in other cases of cystitis. Alkaline draughts (citrate of potassium), anodynes—preferably by suppository, a little belladonna being combined with opium—and rest in bed, with hot hip or full baths, and hot local fomentations, are the most important remedies.

If, after reasonable time and effort, the putridity of the urine cannot be overcome, or the intensity of the cystitis subdued, then, if any operation is to be done, it must be lithotomy, which not only extracts the offending foreign body, but also drains the bladder, leaves it at rest, and thus affords the best chance for recovery from the cystitis, provided that the cystotomy itself be sustained.

(2) *Special Preparation just before the Operation.*—This preparation is more or less rigorous in detail according to the especial requirements of each case. For a child little or nothing need be done, but in the case of an adult, however seemingly well, no harm can result from taking precautions. The preparation is the same for lithotomy and lithotrity, and is to be repeated before each sitting of the latter, if more than one be required.

On the morning of the day of operation the patient should remain warm and quiet in his bed, his bowels should be evacuated, and his stomach should be kept empty, if an anæsthetic is to be used. At about three hours before the time of operating he may take ten or fifteen grains of quinine. A few drops of the strong tincture of aconite is thought well of in some quarters, to ward off shock and prevent chill. I have reaped most success in this line from the combination of pilocarpine and morphia. This may be given by the stomach a half hour before operating, but it is more effective if administered subcutaneously just as the operation terminates. The amount of morphia is to be varied from one-sixth of a grain upwards, if the patient has been accustomed to use it. Of the muriate of pilocarpine I find a dose of from a tenth to a sixth of a grain ample to produce physiological effects, and I believe it to be quite potent in warding off chill.

Before lithotrity, besides all the above-mentioned points of preparatory treatment, the urethra should be gauged to see that there is no obstacle to free instrumentation. The meatus may be attended to at the time of final operation. Anterior stricture should be cut, deep stricture dilated. If dilatation is impracticable, lithotomy should be performed, and both maladies dealt with at once. It is doubtful whether the old-fashioned practice of "training the urethra" by the use of sounds passed at intervals is of any value. The risk of exciting complications when the deep urethra is irritated by the presence of stone in the bladder is great, and local sensitiveness of the urethra, if ether is not used, may be so moderated by the preparatory injection of a four-per-cent. solution of cocaine, that it has become unnecessary. The calibre of the urethra must be determined, but nothing more. In lithotrity and in litholapaxy it is good practice, if the urine is at all foul, to draw it off just before the crushing is commenced, and substitute pure water or borated water, in which to do the crushing.

LITHOTRITY.

All lithotrity, even that known as the old-fashioned operation, is of modern origin. Surgery owes to the genius of France, and to the present century, all that is valuable in this admirable operation. In 1817 the instruments were devised by Civiale, with which he proposed to break up a calculus within the bladder, and in 1824, before a special committee appointed by the Academy of Medicine, he operated successfully upon two patients. This is the first systematic and scientific attempt at lithotrity recognized by history. The term lithotrity is etymologically inaccurate, but usage has earned it a fixed position in classical nomenclature. The most probable derivation is from *λίθος*, a stone; *τερέω*, I pierce; and in this sense the term was entirely apposite, as far as the first operations were concerned, for in them the stone was first seized

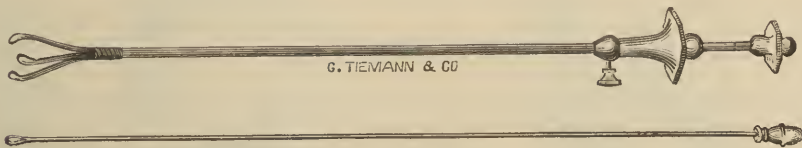
and then perforated by a drill, before it was finally crushed. For the operation at present used, either lithotripsy (grinding a stone) or lithoclasty (breaking a stone) would be more accurate.

Scattered records of various efforts to relieve the bladder of stone without the use of the knife, existed in medical history long before the days of Civiale. The first instance seems to have been that of the monk Theophanes, early in the ninth century. Albucasis, in Arabia, appears to have been acquainted with lithotripsy, at least in theory. The monk of Citeaux is usually referred to in this connection, and, finally, Colonel Martine¹ with his file, made of the end of a knitting needle, well tempered and set in a piece of whalebone as a handle. With this rude tool, pushed through a straight canula, the colonel was wont to rub his stone away, repeating his sittings sometimes twice a day, and often operating in the presence of witnesses. In this manner he finally entirely relieved his bladder; but nobody has testified to the size of the stone or the weight of the débris.

The Bavarian surgeon Gruithuisen² seems to have conceived the idea of lithotripsy in 1809. He published his views in 1813, establishing the possibility of catheterization by a straight tube, and proposing to introduce through this tube a variety of instruments to act upon the stone: a lance-shaped drill, with a wire snare to hold the stone in place; a trephine; a crow-bill forceps to crush the débris; a stone cutter, etc., of all of which he gave plates; but there is no evidence to show that these instruments were ever actually constructed, much less put to the test, even upon the cadaver.

In 1818 Civiale, being then a medical student, presented to the medical faculty an essay upon a new *lithontripteur*, but it was an instrument never used, and apparently not very suitable for the work for which it had been designed. During all this period there seems to have been great activity in the surgical world upon the stone-crushing question. Fournier de Lempdes, in 1812, constructed some special instruments, and tried them on the cadaver at the St. Louis Hospital, in Paris. Elderton, in Scotland, constructed a curved file to be used to wear away a stone. Amussat made some efforts before a commission of the Academy, but his instrument unfortunately broke during the sitting. Leroy d'Étiolles devised an instrument to saw the stone, and Ducamp another, which was tried upon the living subject. Finally, Leroy d'Étiolles perfected a forceps with three branches and a saw (*lithoprione*), in April, 1823, and in the following January, 1824, Civiale's *litholabe* (Fig. 1216), a three-branched forceps with drill, was successfully used upon a living

Fig. 1216.



Civiale's litholabe.

patient. Leroy d'Étiolles³ confessed that he had obtained the idea of his *lithoprione* from a three-bladed forceps (*tire-balle*) of Alphonse Ferri.

Attempts at improvement and modifications of the *trilabe* now became numerous on all sides. Even Civiale attempted a modification, but no prac-

¹ Journal of Science and the Arts, vol. i. p. 199. 1817.

² Art. Lithotritie, Dict. de Méd. et de Chir. Pratiques, tome xxi.

³ Exposé des divers procédés jusqu'à ce jour pour guérir de la pierre, etc. Paris, 1825.

tical advantage was obtained, and all efforts had the same direction and the same general idea, namely, that it was necessary first to weaken the stone by multiple perforations before it could be successfully crushed.

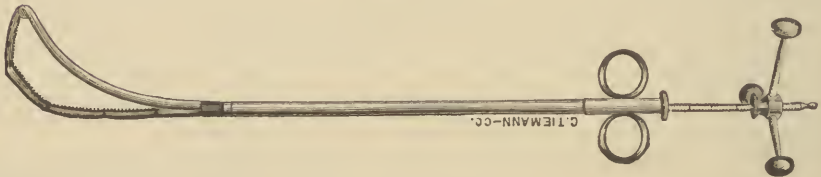
To Jacobson, a Danish surgeon, is due the credit of demonstrating, in 1831, that stones of considerable dimensions might be crushed by simple pressure, without previous perforation. His instrument, the mechanism of which is sufficiently clear (Figs. 1217 and 1218), did very well for the first crushing,

Fig. 1217.



Jacobson's lithotrite, closed.

Fig. 1218.



Jacobson's lithotrite, opened.

but it was difficult to pick up the broken fragments with the loop, and the smaller the fragments the harder became the task, so that although the instrument enjoyed considerable and well merited popularity, it is no longer used.

Meantime attempts to apply the crushing power more conveniently were made in England and in France. Amussat had already, in 1822, devised a

Fig. 1219.



Heurteloup's percuteur.

straight *brise-pierre*, with which to crush small calculi and larger ones which had been perforated, and Heurteloup at about the same time constructed a *brise-coque*; but the final act of evolving the jaws of the lithotrite, as they exist at the present day, is ascribed by the English to Mr. Weiss, the instru-

ment-maker of London, in 1824,¹ and by the French to Baron Heurteloup,² in 1832. Heurteloup's instrument, the *percutateur*, as perfected, is shown in Fig. 1219. A special couch was used by Heurteloup, by which he changed the position of the patient, and consequently of the stone. He had the stem of his *percutateur* so fixed that no shock should be communicated through it to the patient. Afterwards the table was given up, and the side handles shown in the figure substituted, that the hands of an assistant might receive the counter shock of the hammer and the soft parts of the patient be spared.

The first instrument made by Weiss was simply a curved forceps, its hollow tube containing a small saw destined to divide the stone. In England the names of Stodart, Haygarth, Hodgson, of Birmingham, L'Estrange, of Dublin; on the continent, those of Leroy d'Étiolles, Dupuytren, Touzay, Amussat, Ségalas, and others, swelled the list of those applying useful modifications to the lithotrite.

Screw power in the handle was soon employed to take the place of the Heurteloup hammer. The first actual experiments made with it were at the hands of Hodgson, in the Birmingham Hospital, in 1825, but it was not adopted at that date through fear of damaging the bladder by the fragments, as they flew apart from the jaws of the instrument under the pressure of the screw.

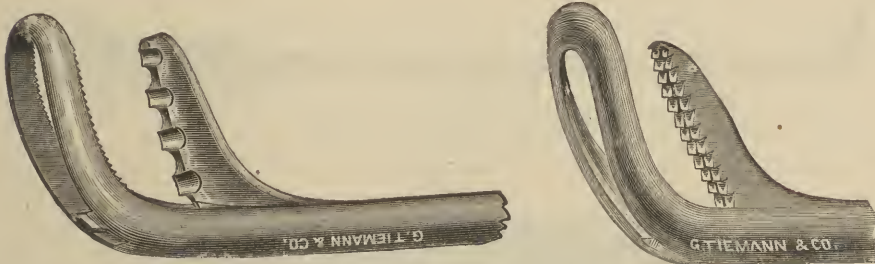
The adaptation to the screw of the rack and pinion by Fergusson, in 1834, finally did away with this fear. Next came the *écrou-brisé* of Charrière, the French instrument maker, in which by a twist given to the handle the screw movement could be thrown on or off at will, and finally the instrument now generally used, which owes its corrugated light cylindrical handle to Thompson, and the sliding button which regulates the screw action to Weiss.

All the lithotrites now in general use resemble each other in their essential features. The jaws are set nearly at right angles to the axis of the shaft. The male blade is more or less roughened; the female blade fenestrated or flat. The old scoop-lithotrites with hollowed blades, whose function it was to bring away as much of the detritus as possible in their bite, after a given crushing, have been discarded. The solid back of the female blade is now only retained that the pulverization of the stone may be more thorough.

All lithotrites possess the light, roughened, cylindrical handle, a screw movement with some mechanism to throw it on and off, and a wheel or rounded handle to work the screw. A marking in centimetres or inches, on the male

Fig. 1220.

Fig. 1221.



Thompson's fenestrated lithotrites.

blade, indicates the extent of separation of the jaws of the instrument. Of the minor variations in shape and detail, there is no end, and they are not

¹ Thompson, Clinical Lectures on Diseases of the Urinary Organs, 6th ed., p. 75. 1882.

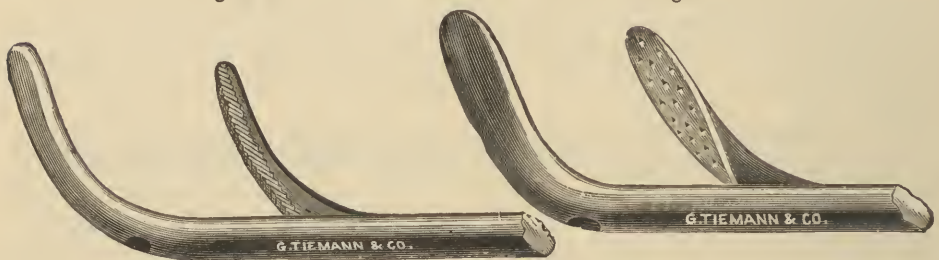
² Art. Lithotritie, Dict. de Méd. et de Chir. Pratiques, t. xxi. p. 663.

very important. Any good operator can do excellent work with any reasonably good instrument, but no instrument, however good, can be counted upon to perform a good operation unless a good hand is behind it, and, better still, a hand more or less trained to this special work.

I shall describe only the lithotrites of Thompson and Bigelow, and the instruments which I habitually use. Thompson uses two instruments, one fenestrated to do the heavier work, the other non-fenestrated for ordinary crushing. He employs two varieties of fenestrated lithotrite, that shown in Fig. 1220 being the old-fashioned one, and obviously far less powerful than its younger rival (Fig. 1221), in which the male blade passes entirely through the female. He uses also two forms of non-fenestrated lithotrite. Fig. 1222 shows that used in intermediate work, with reasonably large and hard fragments. Its male blade is narrow and slightly wedged in shape. That seen in Fig. 1223, with its broad, flat male blade is for final pulverization of the frag-

Fig. 1222.

Fig. 1223.



Thompson's non-fenestrated lithotrites.

ments. The toughest steel, cut, not forged, is used in the manufacture of all these instruments.

Fig. 1224.



Thompson's lithotrite, male blade.

Fig. 1225.



Thompson's lithotrite, female blade

Fig. 1226.



Handle of Thompson's lithotrite.

Figs. 1224, 1225 represent the male and female blades of the Thompson instrument, when separated, and Fig. 1226 shows the handle closed.

Bigelow uses two instruments of the same pattern, one corresponding in size to about No. 25 of the French scale, the other to about No. 30, at the junction of the shaft with the jaws. (Figs. 1227, 1228.) He says that the spur in the heel, together with the narrowness of the male blade, effectively

Fig. 1227



Fig. 1228.

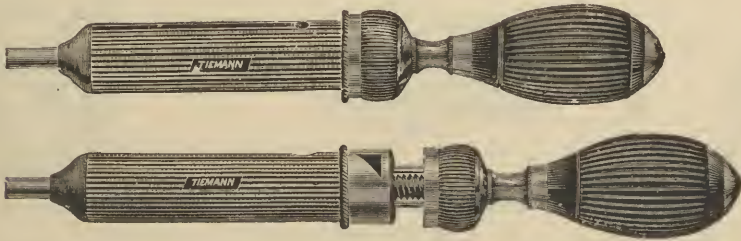


Jaws of Bigelow's lithotrite.

prevent clogging. The forward curve at the toe of the female blade was devised by Bigelow to facilitate the introduction of a large instrument with long jaws through a large prostate.

Bigelow believes that quicker and more powerful work can be accomplished by the wrist motion of rotation than by the fingers upon a wheel. Therefore he makes the handle of his lithotrite of solid hard-rubber, and pear-shaped. (Fig. 1229.)

Fig. 1229.



Handle of Bigelow's lithotrite.

The method of throwing on the screw power in Bigelow's instrument is also an innovation. It is effected by a collar upon the end of the cylindrical handle, and is thrown into action by rotation conformably to the general wrist motion used in manipulating the screw. This instrument is larger and heavier than other models. It is very effective for rapid work, and the male blade is so small, and its asperities are so arranged, that it is with difficulty that a fold of the bladder can be pinched. It requires a little training to work the handle readily.

The instruments which I use are all fenestrated, so that the male blade may be made to pass just beyond the female blade, if necessary. Such an instrument cannot, by any possibility, clog with any substance out of which stone is formed. For litholapaxy there is no object in carrying fragmentation to trituration—small fragments will pass the tube as well as dust, and are less likely to flow back with the return current. For old-fashioned lithotritry a narrow fenestra is all that is required, that the fragments may be made very small; but as long sittings are not allowable with this operation, the non-fenestrated lithotrite is suitable when it is practised.

Coulson uses a fenestrated lithotrite; Billroth and Dittel use Reliquet's, which is partly fenestrated. The German surgeons have modified it slightly. Guyon, who has done more operations than any one else, uses only fenestrated lithotrites, having three sizes, suitable for the various sizes of urethra and of stone.

The instruments which I employ are three: Fig. 1230 shows the jaws, and Fig. 1231 the handle, of the larger and stronger instrument. The pattern of

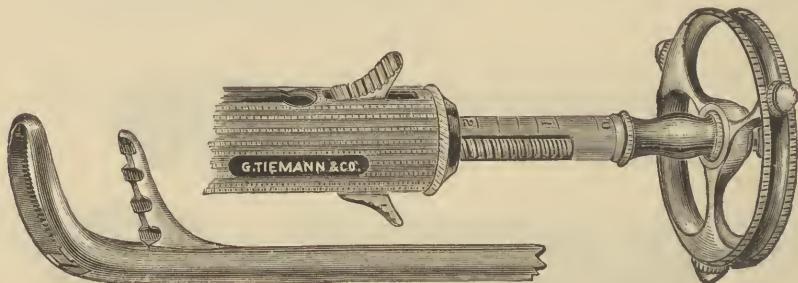
Fig. 1230.



Jaws of Keyes's lithotrite.

the jaws is the same in all. The three sizes are to accommodate variations in the size and hardness of the stone. I prefer the Reliquet pattern of rough-

Fig. 1231.



Keyes's lithotrite.

ening the male blade. The instrument is narrow, but exceedingly strong. It grasps well, and cannot clog. With any reasonable care it is unlikely to catch a fold of the bladder in its bite.

For purposes of experiment I have caught up a fold of the bladder in the dead subject with Bigelow's, Thompson's, and my own instrument. It is not difficult to do this, and not difficult to recognize the bladder when caught, nor is it difficult to drop the bladder uninjured after the operator becomes conscious that it is caught.

A few words will account for the creation of my instrument. In 1876, I received from Paris a Reliquet's lithotrite, made by Collin. I was delighted with its grasping power, but the jaws clogged badly the first time I used the instrument, and could not be freed. In extracting them the point of physiological narrowing of the urethra, at two and a half inches from the meatus, was slightly torn, and death from pyæmia followed this one sitting—of the old operation without ether—the calamity being due, in my opinion, entirely to the laceration of the urethra. I had previously scratched a urethra disagreeably, but not mortally, while using a Thompson's non-fenestrated lithotrite, and bringing out an angular piece which could not be dislodged from its

jaws. I therefore determined to use always a fenestrated lithotrite, and as the only instruments of that sort then in existence, within my reach, had sharp cutting edges upon the male blade, and were dangerous instruments for rapid use, I simply took the Thompson's non-fenestrated instrument, and had cut in its back a fenestra large enough to allow the sole of the male blade to pass through it. This instrument never clogged; it was almost impossible to catch the bladder with it; and by its aid all my earlier operations of litholapaxy were performed. But it proved by no means large enough or strong enough for heavy work, wherefore I had the back of the female blade cut out of the Reliquet's instrument. This gave great satisfaction, and out of it grew the instrument I use.

I have had one large instrument made with the forward curve at the toe of the female blade, as advised by Bigelow, for ease of introduction; but although this object is attained, yet I look upon the second curve as a disadvantage, because this irregularity in the length of the blades makes it impossible, when the instrument is reversed in the bas-fond of the bladder, to pick up very flat or small fragments. I have demonstrated this on several occasions, using first the lithotrite with the double curve in vain, and then a similar instrument without this forward curve, with prompt success.

In the handle of my larger lithotrite, I have placed two buttons, so that any finger of either hand, in any position, may strike a button easily, and promptly connect the screw. Either button works alone, or they work together. They are saddle-shaped, high, and much easier to work than those of the older models.

All instruments now have the thread of the screw more oblique than formerly, to increase the rapidity of action. I have very materially enlarged the wheel, thus more than making good the consequent loss of power. The larger instrument will lock upon a stone two and a half inches in diameter.

For old-fashioned lithotritry, no instrument except the lithotrite is required, unless it be a searcher, and instruments for removing impacted fragments from the urethra.

MODE OF PERFORMING LITHOTRITY.—All the preliminary steps laid down under the head *Preparation of the Patient* (p. 784), having been attended to, the patient is placed on a hard couch or a table, upon his back, with the head comfortably raised, the shoulders low, and the hips elevated upon a hair cushion, so that they shall be higher than the shoulders. This allows the stone to roll away from the neck of the bladder toward the fundus, and favors the manipulation of the jaws of the instrument at the point of greatest safety, as far as possible from the neck of the bladder. The bladder should contain, if possible, from two to four ounces of fluid, and, unless an operator has accustomed himself to work in a bladder empty as well as full—which it is not difficult to do—a little borated warm water, at 100° F., may be injected through a soft catheter before the sitting commences. If thought proper, the bladder and urethra may first be injected with a four-per-cent. solution of cocaine. The operator stands upon the right side of the patient.

The lithotrite is introduced as if it were a searcher, that is, after its beak passes the hole in the triangular ligament, its heel is made to slide along the membranous urethra and floor of the prostatic sinus by pressing the shaft in the direction of its axis, at the same time that the handle is being slowly depressed. The penis may be pulled upon, or its suspensory ligament relaxed by pressure with the left hand, while executing this manœuvre. The only precaution necessary is not to depress the handle too rapidly, for by so doing the roof of the prostatic urethra might be injured. When the prostate is large, and its urethral segment lengthened, the lateral compression of the urethra

by the large prostatic lobes may make its vertical capacity greater than usual, and give the operator the impression that the beak of his instrument is in the bladder while it is still in the prostatic sinus. Sudden depression of the handle at this point is a serious blunder. It may always be avoided by remembering to continue the sliding motion until a lateral turn proves the beak to be free in the vesical cavity, when the handle may be depressed at will.

Once within the bladder, the lithotrite, still closed, is advanced gently until it reaches the posterior wall, and here it usually encounters the stone. The closed jaws are pushed beyond the stone, a tap by rotating the handle locates its position accurately, the beak of the instrument is turned away from the stone without moving the heel from its position, the male blade is withdrawn sufficiently far to seize the stone, whose diameter is known by previous measurement, and then by gentle rotation the open blades are thrown over so as to embrace the stone. The male blade is now pushed in until the stone is grasped, then the button is moved, the screw connected, and at the same moment the whole instrument containing the stone in its grasp is rotated upwards and drawn outwards so as to carry the stone toward the centre of the bladder. If a fold of the bladder has been seized with the stone, this last movement frees it, or at least informs the operator of what has happened.

The stone once safely raised from its bed, the screw power is applied. If the stone is soft, the male blade advances at a uniform rate. If the stone is hard, and badly caught, it shoots out of the bite of the instrument. If it is well caught, but very hard, the screw cannot be turned. There is in such a case a very palpable rebound communicated by the stone to the male blade, which an operator soon learns to distinguish, and judgment about which is the measure of his sagacity, for if he attacks such a stone clumsily he may break his lithotrite and jeopardize his operation.

If the operator concludes that his instrument will not crush the stone, he drops the latter and tries a heavier lithotrite. If he determines to continue, he holds the cylindrical handle firmly, and makes repeated, light, forward and backward motions with the screw in a jerking manner, thus communicating to the stone the effect of a blow as well as sustained pressure, or he may screw the male blade as firmly as he dare, and hold it so until suddenly the stone splits. One of these manœuvres will succeed if the instrument is powerful enough for the stone in question.

The large fragments of the first fracture fall on either side of the closed jaws, but one at least usually drops into the spot where the stone was first seized. The opening and shutting of the jaws is therefore again repeated as before, and again, and again, as many seizures being effected as the patient will tolerate, for presently his power of endurance fails and he demands relief. The jaws being disengaged, and free from débris, the instrument is now gently withdrawn.

The limit of time formerly agreed upon, during which a sitting might be prolonged, was three minutes; and as many seizures as possible were made, perhaps a dozen, enough to crush a small stone completely, or so to reduce it that it could pass the urethra.

Another method often called into play, is to make the stone or fragment gravitate into the jaws of the instrument. This is done by pressing the female blade with moderate force against the back wall of the bladder, while the male blade is held forward.

This position alone may insure success through the action of gravity upon the stone lying loose in the bladder, so that when the jaws are closed the stone will be seized. If the stone, however, does not voluntarily seek the female blade, it may be jarred into position by gently striking the pelvis.

When seized, the stone is carried to the centre of the bladder, and is dealt with as before.

Last fragments are often very difficult to find. The lithotrite may be used as a searcher, tapping various portions of the bladder until a fragment is touched, but when the piece is thus located the tip of the lithotrite must be turned away from it, and the jaws then opened to be again rotated toward the suspected area for the purpose of embracing the stone. If the jaws are opened on the spot where they encounter it, one or other of the blades is pretty sure to displace the fragment.

In old men, the *bas-fond* behind the prostate may constitute a veritable pouch out of which the stone or fragments will not roll, and the instrument must be made to pick them up within it. This is accomplished by reversing the lithotrite so that its beak looks downward, and commencing at the back wall of the bladder to explore the floor by to-and-fro movements, as the beak is gradually drawn toward the vesical neck. A short-beaked instrument with square tip and broad male blade is suitable for this manœuvre. As soon as a fragment is touched, the beak of the lithotrite is turned away from it, opened, and, returning over the same spot, again closed to grasp it. The operator may now rotate the beak entirely before crushing, or simply move it to one side, to be sure that he has not picked up a fold of the bladder along with the fragment.

In all manœuvres of the lithotrite within the bladder, particularly in the one last mentioned, great care should be employed in every movement, so as to jar, bruise, and scrape the tender soft parts as little as possible.

Subsequent Crushings.—It was formerly the rule in lithotrity to keep the patient in bed after his crushing, and not to operate again until the disturbance caused by the first sitting had subsided; and the same rule is still applicable with all its force when more than one crushing is required. But in these days it is doubtful whether any stone is suitable for old fashioned lithotrity, unless it is so small that it can be easily crushed in two or three seizures. In those exceptional cases, however, where several sittings are required, each subsequent operation is to be performed after an interval of several days or a week, or such time as may be necessary for the bladder to rally from the irritating effects of the previous manipulations.

It must here be remembered that in any case, if the inflammation run high after a given crushing, and considerable calculous débris remain in the bladder, especially if the fragments be hard and large, the proper treatment is to give ether and disembarass the bladder at once of the offending element by litholapaxy.

After-treatment.—After the sitting, the patient is replaced in his bed, warmly wrapped, with hot bottles at his feet if he has been chilled by the exposure of the operation, and a hot, dry application over the bladder, with perhaps a warm drink (without alcohol). He must not be allowed to pass water except upon his back, or rolled over on his side, during at least the first twenty-four hours after the crushing, and in some cases, if there are to be several sittings, it is better for the patient always to lie down to pass water until the bladder has been entirely emptied of fragments; otherwise he runs the risk of an angular fragment becoming impacted in the urethra.

The urine should all be strained through a fine sieve or coarse cloth, and the sediment dried and collected for weighing. A suitable anodyne should be administered during several days, and should be pushed if there is any tendency to vesical spasm or inflammation. An alkali or diluent may be given with advantage in most cases. Milk forms a suitable diet. Any chilling of the patient is to be strictly guarded against. After forty-eight hours the patient may get up and remain about, avoiding cold, being careful of his

movements while in the erect posture, and lying down, if possible, every time he urinates.

COMPLICATIONS OF LITHOTRITY.—The complications of lithotritry may be divided into two classes, those attending the operation and those following it.

Complications during the Operation.—These are escape of urine, vesical spasm, and hemorrhage.

(1) *Escape of Urine.*—As the lithotrite is being introduced, or after it is fairly in the bladder, whether an anæsthetic has been used or not, the bladder will sometimes involuntarily empty itself, the fluid escaping in a stream alongside of the instrument. It is proper under such circumstances to grasp the penis and compress the urethra about the shaft of the lithotrite, without withdrawing the latter, and after a moment's delay to proceed with the operation. In case this does not suffice, a flat tape may be tied with moderate firmness about the body of the penis, over the shaft of the lithotrite, and the operation may go on; but it is usually better either to finish the sitting with the bladder empty, which may be safely done by an experienced operator using a lithotrite with a smooth male blade, or the sitting may be postponed to a more favorable occasion when the bladder may be less irritable, and the precaution may be taken before this subsequent sitting to administer morphia subcutaneously.

(2) *Vesical spasm* during the operation is a rare but a disagreeable complication. The bladder may be only partly empty, or the spasm may spurt out what fluid it contains, often with an exhibition of decided suffering, if an anæsthetic has been used, and with cries of pain from the patient if it has not; the deep urethral muscles and the vesical walls grasp the lithotrite, and fix it in position so that it can no longer be rotated, and sometimes it is rather tightly retained if an effort is made to withdraw it.

With a bladder in such a mood, further operation is generally impossible. Sometimes the spasm is quite short, and, if the lithotrite is left at rest, promptly subsides and does not recur. Usually, however, it repeats itself, and the prudent surgeon retires his instrument as gently as possible, acknowledging defeat, and promising himself aid from his ally morphia before making the next aggressive move.

(3) *Hemorrhage* during an operation is usually seen only in such drops of blood as, starting from a scraped patch of urethra, ooze forwards along the shaft of the instrument, or in a gush of urine stained with blood forced out by vesical spasm. Such indications, although unpleasant, are not serious, and do not call for a termination of the sitting. Aston Key has recorded a case in which hemorrhage was so severe during attempted lithotritry that it was deemed prudent to abandon the operation and perform lithotomy.

Complications after the Operation.—These are retention of urine, urinary fever, hemorrhage, impaction of a fragment in the urethra, cystitis, epididymitis, and surgical kidney.

(1) *Retention of Urine.*—This is a complication not particularly uncommon after the manipulations of old-fashioned lithotritry. It occurs also sometimes after the longer sittings of litholapaxy. It is due to spasm of the sphincters and cut-off group of urethral muscles, excited by the irritation of the mucous membrane about the membranous urethra. A warm bath, hot fomentations, and an anodyne may relieve it; if not, after moderate delay, it is proper to introduce a small soft catheter.¹ The urine so drawn off will generally

¹ A silk instrument, recently placed upon the market by Eschman Bros. & Welch, St. Bartholomew's Square, London, seems to be a model of perfection in its way, possessing all the flexibility of soft rubber with far greater rigidity, and a very much higher finish than rubber.

contain more or less blood, and it is wiser before withdrawing the catheter to wash the bladder out with a hot borated solution.

One passage of the catheter may be all that is required—or its use may have to be persisted in for several days. In the latter case, the bladder should be washed after each instrumental withdrawal of the urine, but if there be no retention, vesical irrigation is not called for in ordinary cases.

(2) *Urinary fever* may complicate lithotrity. It is always announced by a chill, and full of uncertainty as to its issue. It may come on promptly, be attended by suppression, and end in speedy death. Generally, if the chill does not occur until near the end of twenty-four hours, the fever will not be very intense, and if its advent is postponed as late as the second twenty-four hours, little harm may be expected from it. Any chill occurring later than forty-eight hours is more likely to portend some graver complication than urinary fever, such as active cystitis or surgical kidney. When a chill occurs it is always a grave matter. Its significance is necessarily involved in doubt. It may be followed only by a slight rise in temperature, with a critical sweat, after which order is restored and no further annoyance experienced, unless perhaps an outcrop of “fever-blisters” on the lips or elsewhere—an appearance always to be hailed with delight as indicating that the worst is over. On the other hand, the sweat following the fever may be delusive, higher temperature may succeed, and pyæmia, cellulitis, surgical kidney, or some other grave complication may follow.

It is presumed that all the precautions to avert urinary fever laid down in the section on preparation of the patient have been taken, but over and above these precautions, if the surgeon is at hand when the chill occurs, a subcutaneous injection of a small dose of pilocarpine and morphia may be given (gr. $\frac{1}{10}$ in $\text{m} \vee$ of Magendie’s solution), and a hot drink containing some ammonia or alcohol—more or less, according to the patient’s condition. Warm applications of various kinds may then be made, and the remainder of the treatment conducted symptomatically. The patient requires close watching. His temperature should be often taken, and any physical complication which arises to explain the chill dealt with according to its needs. After a chill, the patient should be kept upon quinine, gr. v –xxx daily.

(3) *Hæmorrhage*.—Moderate hæmorrhage is customary after lithotrity, and need cause no uneasiness. Occasionally it is excessive. Thompson has reported two fatal cases, in one of which villous growths in the bladder were the cause, while in the other a post-mortem examination showed that “the whole mucous membrane of the bladder was greatly congested.” Generally the urine ceases to be bloody after a short time, and no special treatment is called for by the bleeding in any case, except an anodyne to quiet the contractions of the bladder, and warm borated irrigation, if retention or atony demands the use of the catheter.

(4) *Impaction of a Fragment in the Urethra*.—This disagreeable accident ought never to occur. If the fragments left in the bladder are not small enough to pass easily, either the operation has been imperfectly done, or the case should have been treated by litholapaxy. But it is possible for a fragment to be left under any circumstances, and urethral impaction may ensue.

If a fragment does become lodged in the urethra, the impaction is likely to take place at the bulbo-membranous narrowing of the canal, more rarely at the middle of the pendulous urethra, or near the meatus. In the first-mentioned situation it gives the most trouble, occasioning sometimes severe pain, and producing muscular spasm of the cut-off muscles even to the extent of causing retention.

The removal of urethral calculi has already been considered (page 746), and to that section the reader is referred for the different methods of remov-

ing foreign bodies from the urethra. Among all the instruments employed, my experience has led me to adopt the divulsor used as a forceps, for the reasons which I have already stated. But this instrument has not been commonly employed. Among those in ordinary use may be mentioned, as having received general sanction, the long urethral forceps (Fig. 1232), and the alligator

Fig. 1232.



Urethral forceps.

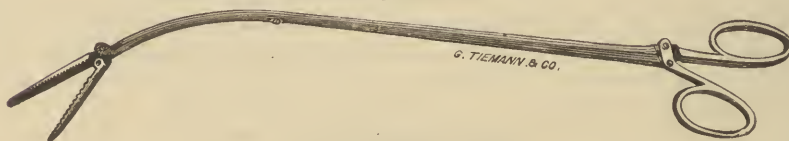
forceps, straight and curved (Figs. 1233, 1234). My experience with all these instruments is, that they pinch, scratch, and tear the urethra, and that it is

Fig. 1233.



Alligator forceps, straight.

Fig. 1234.

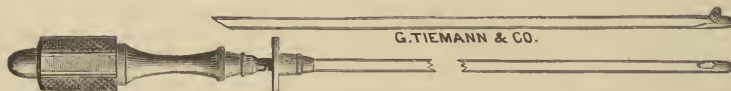


Alligator forceps, curved.

difficult with them, often impossible, to seize a foreign body and extract it, especially if the latter be angular and impacted.

A very ingenious instrument, and one which may serve when the foreign body is impacted far forward, is the articulated scoop of Leroy d'Étiolles. Fig. 1235 represents it—open and shut. The urethral lithotrite is an adap-

Fig. 1235.



Leroy d'Étiolles's scoop.

tation of a small male blade to a steel instrument, fashioned like the scoop of Leroy d'Étiolles, and in which the female blade is worked by an analogous mechanism (Fig. 1236). Mathieu, of Paris, has devised an ingenious instrument for reducing urethral stone to fragments. Fig. 1237 shows it, closed for introduction, and at work. The mechanism is in the handle. The stone is caught in the hollow of the closed female blade. Then, by rotation, half the female

blade goes around the foreign body and incloses it, after which the perforating male blade is advanced.

Fig. 1236.

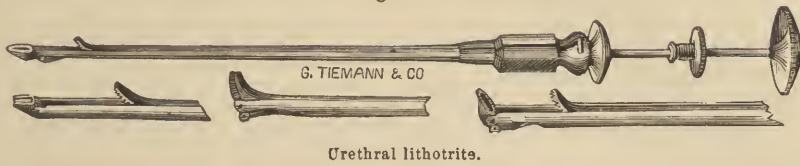


Fig. 1237.



(5) *Cystitis*.—A moderate amount of superficial cystitis was not unusual after old-fashioned lithotritry, if the fragments left after the first crushing were large. It was indeed this well-known tendency which induced the English surgeons present at the meeting of the Royal Medical and Chirurgical Society of London, in 1878,¹ to lean toward the conclusion that lithotritry had been pushed too far; that, except for small stones, lithotomy was a better operation; and that in the future more stones should be cut for, and fewer crushed. And it was partly by reasoning upon the same premises that Bigelow had at about the same date reached exactly the opposite conclusion, namely, that a stone, however large, was suitable for lithotritry, provided that it could all be removed from the bladder at one sitting. Bigelow's solution of the problem was the invention of litholapaxy.

As matters stand to-day, therefore, the question of cystitis after lithotritry is not a serious one. Large stones are no longer dealt with by old-fashioned lithotritry, and much cystitis does not follow upon crushing a small stone. Litholapaxy, on the other hand, leaves the bladder empty, and the most important causative factor of cystitis is removed.

The treatment of cystitis following lithotritry is the same as that of cystitis from other causes—rest in bed, hot applications locally and hot baths, alkalis and diluents by the stomach, anodynes as may be required—with use of the catheter and vesical injections in appropriate cases. If it so happen that fragments of any considerable size are left in the bladder, and that cystitis of a high grade supervenes, the surgeon's duty is plain. He must relieve the tender mucous membrane from the repeated injuries it is receiving from the sharp fragments, and a second thorough sitting of litholapaxy, under ether, and lithotomy, are his legitimate alternatives.

In such serious cases as have sometimes been recorded, where the superficial cystitis is complicated with interstitial inflammation of the walls of the bladder, the formation of abscess, peri-cystitis and para-cystitis, the surgeon must be guided by general principles and meet the indications as they arise. Occasionally, but very rarely, chronic cystitis with a tendency to phosphatic re-accumulation follows lithotritry, even when the stone first removed has

¹ Lancet, March 16, 1878, p. 385.

been formed of uric acid, and the bladder has been in fair condition at the time of operating. (Thompson.)

(6) *Epididymitis* occasionally occurs as a complication of lithotripsy. It is due to the damage inflicted upon the deep urethra by the instruments employed, or sometimes to the impaction of a fragment in the urethra. In the case of very old men it may possibly develop into a true orchitis, and the latter may culminate in abscess. I have seen one instance of this complication. Ordinarily, however, epididymitis is a very trifling matter, terminating in resolution in from two to ten days, and only notable on account of the annoyance which it occasions. Its treatment is by the use of hot anodyne applications and local support, the patient remaining in bed. No further sitting of lithotripsy should be undertaken until the epididymis and cord are free from any tenderness on pressure.

(7) *Surgical kidney*, fortunately a rare complication, will be considered in speaking of the complications of lithotomy.

SEARCH FOR THE LAST FRAGMENT.—The reproach is constantly made against lithotripsy that a fragment is often left behind, and that relapse becomes, therefore, inevitable. No patient should be deemed well after lithotripsy until his final searching has proved him well, and modern methods of searching are nearly absolute in their conclusions. Phosphatic re-accumulation does occur, but this is not relapse, and does not depend upon the persistence of any nucleus left behind in the bladder.

Such rough methods as making the patient ride a long distance in a vehicle without springs, over a rough road, before calling him well after treatment for stone, are no longer employed; nor is the condition of the urine a trustworthy test, for it may continue to show pus long after the last fragment has been removed. Nor can the searcher be relied upon with confidence, for if even a large stone may sometimes elude the searcher in skilled hands, how much more a minute fragment! The method of to-day, which ranks all others in accuracy, is the use of the washing-bottle, as employed in litholapaxy, with a small metallic tube. It is not much more painful than sounding with the searcher, if the bladder be not over-sensitive; and if it is so used that not a bubble of air is allowed to enter the bladder, there is no test which approaches it in accuracy for detecting a final fragment.

Every patient should be subjected to this test before he is pronounced well, and the test should be reapplied after several months.

LITHOLAPAXY.

Bigelow has chosen this name (from λίθος, a stone, and λάπαξις, evacuation) to indicate his operation for the removal of stone. It is essentially lithotripsy with the aim of reducing the entire stone to fragments and removing it through a tube by suction at one sitting, without regard to the amount of time consumed. More than three hours have been thus consumed without any resulting harm. Special apparatus for washing, and various tubes and lithotrites have been devised, in order to execute the manœuvres of the operation more promptly and effectively; but the essence of the operation consists not in the instruments, but in its design—in the method—and litholapaxy might be effected by any lithotrite, a soft catheter, and a piston syringe, if no better implements were at hand.

That litholapaxy has established for itself a recognized position, is plain. In England it has been adopted by Thompson, Coulson, Harrison, and Teevan; in Germany by Billroth, Dittel, and Ultzmann. I have noticed no report

from that sturdy old lithotritist of the old school, Ivanchich. In France, Guyon is loud in its praises. In America, Van Buren, Caswell, and a host of others in the States and in Canada, have given it their warmest adhesion, while reports are beginning to come in from other sections of the globe.

J. G. Kerr¹ announces that the operation has taken root in his Missionary Hospital at Canton. P. J. Freyer² praises it from India, reporting 111 cases. Zamcarol,³ from the hospital in Alexandria, Egypt, announces 14 cases with 2 deaths. H. Blanc⁴ has made two reports from Bombay, one of six, a second of ten cases, all successful. G. E. Post⁵ has furnished a case from Syria. These have fallen under my notice, and doubtless many more have escaped me. It is rare that a word of serious discontent is heard, although minor criticisms on the operation are not infrequent. In France, I believe that the operation has not been warmly received except by Guyon. Reliquet does not approve it.

The history of litholapaxy is that of lithotripsy. Indeed, the pioneers of old lithotripsy set for themselves the task of freeing the bladder of the débris made by the lithotrite, and invented special spoon-shaped scoops, acting like lithotrites, to effect this object. Civiale's sittings, very long at first, decreased in length as the operator gained in experience, and had become reduced to the conventional two or three minutes when Thompson took up the banner in England. Heurteloup⁶ strove to clear the bladder at a single sitting, and publicly announced this to be his especial aim, but he had no anæsthetic, and his methods were rough and did not find favor. Heurteloup,⁷ indeed, stated in so many words that it was not proper to crush a stone, and then leave the fragments in the bladder, but that the object of the operation ought to be to free the bladder of all débris and send the patient away cured.

Kirmisson⁸ has forcibly brought out the fact that Heurteloup aimed at evacuation fully as much as at crushing, since he proposed a new name for the operation—"Lithocénose" (λίθος, stone, and κένωσις, extraction). Leroy d'Etiolles,⁹ before the *Académie des Sciences*, April 27, 1846, announced that he could extract from the bladder at a single sitting a stone thirty-five millimetres in diameter (something over $1\frac{1}{2}$ inch), and at the same meeting boasted of success by the method of immediate extraction in over a hundred cases. Yet this method never gained favor. Anæsthesia had not been discovered. The means employed to evacuate the débris were crude and mechanically imperfect. In the hands of the general operator, much damage must have been done which was never recorded, and even the prince of operators, Civiale, gave up the method entirely, reducing his sittings to a very short limit. Heurteloup, before the end of his career, gave up the effort to relieve the bladder in one act, and short sittings repeated at intervals became the universal practice in lithotripsy.

Heurteloup went to England and introduced French lithotripsy there, and in 1831 he published a book in London on the principles of the operation.

But the champion of English lithotripsy is alive to-day. Sir Henry Thompson has done more in his day and generation for the operation than any one except Bigelow, and, indeed, it looked at one time as if Thompson were slowly working up to the method of rapid evacuation now in use, when the

¹ Medical News, April 7, 1883, p. 382.

² Lancet, Feb. 28, 1885, p. 378.

³ Soc. de Chirurgie, 7 Déc., 1881; Le Progrès Méd., 10 Déc., 1881.

⁴ Lancet, July 10, 1880, p. 49, and May 27, 1882, p. 857.

⁵ Ibid., July 9, 1881, p. 47.

⁶ De la lithotripsie sans fragments au moyen des deux procédés de l'extraction immédiate ou de la pulvérisation immédiate des pierres vésicales par les voies naturelles. Paris, 1847.

⁷ Mémoire lue à l'Académie Impériale de Médecine de Paris, pp. 301-9. 1857.

⁸ Des modifications modernes de la lithotritie, p. 4. Paris, 1883.

⁹ Comptes rendus des Séances de l'Académie des Sciences, t. i. p. 709. 1846; and Gaz. Méd. de Paris, 2 Mai, 1846, p. 354.

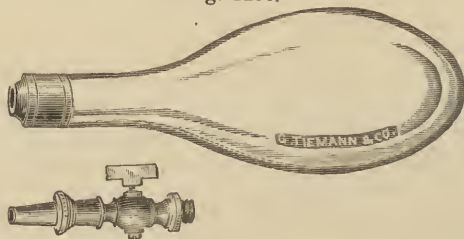
unfortunate death of Napoleon III., under a second sitting of lithotrity—which might indeed have been called litholapaxy, for chloroform and Clover's evacuating suction-apparatus were used—with other circumstances, seemed suddenly to divert him from his progressive course. Up to this time Thompson had been teaching and practising longer sittings, more frequent use of anæsthesia, and more constant recourse to Clover's evacuating apparatus. He had also been urging as a proper course, in the event of active inflammation of the bladder following a first sitting, that the patient should be etherized without delay and his bladder at once cleared of débris by the use of the washing bottle, as a proper treatment of the cystitis. Surely this was litholapaxy, but Thompson did not seem to appreciate it or to accept the spirit of the method, for we find him in March, 1878, three months after the appearance of Bigelow's first announcement of litholapaxy, reading a paper before the Royal Medical and Chirurgical Society of London, advocating shorter intervals between the sittings, it is true, but concluding that in future more stones must be cut for and fewer crushed; and that only small stones were suitable for lithotrity—such as could be dealt with in three or four sittings.

Bigelow appears, from his own writings, to have arrived at his perfected operation partly by inductive reasoning and partly by experiment. The views of Otis as to the calibre of the urethra, and the patient tolerance of that canal under very wide distention, were being freely noised abroad. Bigelow had been in the habit of prolonging his sittings of ordinary lithotrity for from ten to fifteen minutes, and no harm had come from it, and the further lengthening of the sittings, the recognition of the value of prompt removal of the detritus, the adoption (practically) of the Otis standard of urethral calibre, and the construction of some large, thin-walled metal tubes with an ingenious suction apparatus at the distal end, made his operation, which only needed to be modified by experience to become perfect.

This operation is to-day accepted by Thompson, and is described in the last edition of his *Lectures* to the exclusion of old-fashioned lithotrity, which he apparently no longer performs. Indeed, the new operation promises in a few years to displace the old one entirely, and for the most part to do away also with lithotomy for males who have passed the age of puberty.

Irish surgeons have seemed inclined to ascribe the origin of the idea of litholapaxy to Sir Philip Crampton,¹ who at the opening of the Meath Hospital, in Dublin, showed an evacuating bottle (Fig. 1238) which he had

Fig. 1238.



Sir Philip Crampton's evacuating bottle.

devised for drawing away the urine from an atonied bladder in which lithotrity had been performed. The bottle was of glass. The air was exhausted from it and its stopcock turned. Then a Heurteloup's large-eyed steel catheter was introduced into the atonied bladder full of water and crushed stone,

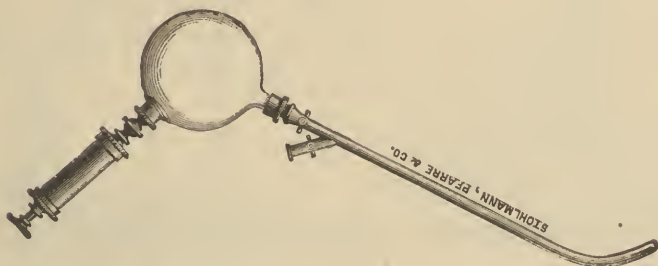
¹ Dublin Quarterly Journ. of Med. Science, vol. i. p. 1. 1846.

the bottle was attached, and the stopcock turned. The case of a Mr. Rodger, aged 70, is reported. His bladder was atonied. Heurteloup had previously operated upon him, but without entire success. Crampton relieved him by the aid of the evacuating bottle.

Bigelow was fully aware of Crampton's device, and refers to it in his paper, but Crampton did not for a moment contemplate the idea of litholapaxy. He simply adopted an expedient to lend power to atonied muscles, and to expel the contents of a bladder the walls of which were incapable of performing that function for themselves. Heurteloup, too, used a large-eyed steel catheter with jointed stylet, and doubtless often washed out the bladder through it, but he did not conceive the idea of litholapaxy. Various other inventors from time to time devised evacuating tubes, to which syringes, rubber balls, or evacuating pumps were attached.

Among the most prominent names are those of Leroy d'Étiolles, Cornay, Mercier, Nélaton, Maisonneuve, Clover, and Coxeter. Cornay's *lithérétie* (Fig. 1239) was described in 1845, one year before Crampton's bottle, which it

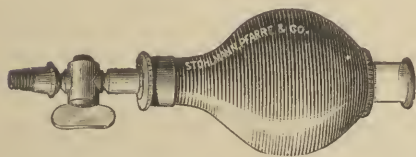
Fig. 1239.



Cornay's lithérétie.

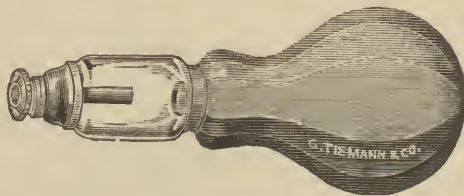
resembled in many respects, differing in that it combined the possibility of injecting the bladder through a double-current catheter with the principle of pneumatic aspiration. Mercier, in 1872,¹ published a description of a washing bottle (Fig. 1240) made of rubber, oval in shape, with a glass receiver for

Fig. 1240.



Mercier's washing bottle.

Fig. 1241.



Clover's first evacuator.

fragments below. It very closely resembles in principle, and, indeed, in appearance, some of the first washers used by Thompson and Bigelow, and was worked without valves by alternate compression and relaxation of the rubber-bulb filled with water, while the fragments collected below in the glass receiver. But Mercier did not dream of litholapaxy. He states distinctly² that he had devised his washer for use "quand la rétention devient

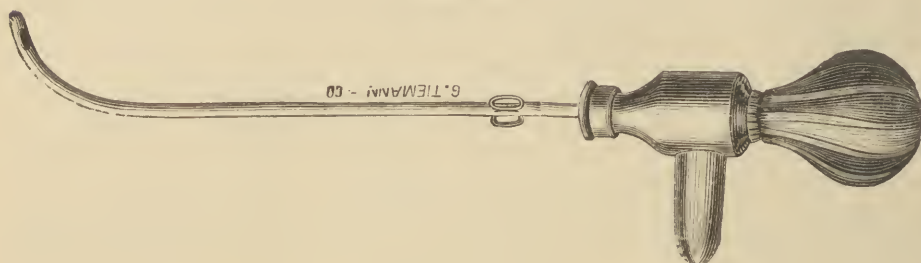
¹ Traitement préservatif et curatif des sédiments, etc. Paris, 1872.

² Op. cit., p. 370.

complète"—in other words, to help the bladder out when it should prove inadequate to the task of expelling the urine and the débris.

The English rubber suction-bottle, known as Clover's apparatus (Figs. 1241, 1242), having a glass receiver, and a metallic catheter with large eye,

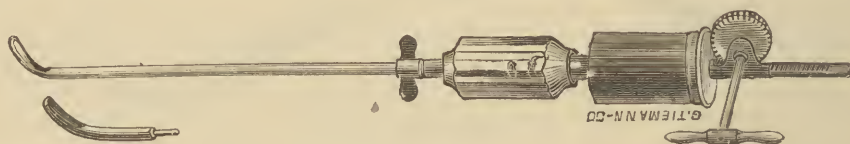
Fig. 1242.



Clover's improved evacuator.

or open at the end, is one of the best models of the old type of instrument. With it Thompson did good work before better washers were provided. The same tube, with a metallic pump above the receiver, was known in France as Nélaton's evacuating apparatus (Fig. 1243).

Fig. 1243.



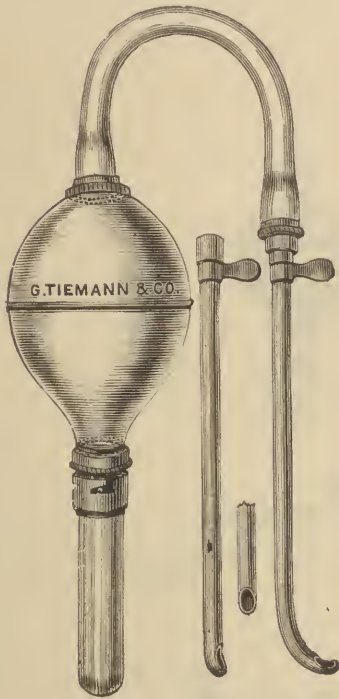
Nélaton's evacuating apparatus.

Bigelow's first evacuator had the demerit of admitting air into the tube, which greatly interfered with the proper function of the instrument. Many modifications and devices have since appeared. I shall give illustrations showing the changes, but shall only describe the instrument as perfected. It is entirely possible that before these words appear in print, new and important modifications may be made, though it is hard to imagine a washer that could work more perfectly than Bigelow's latest pattern. I have used all the varieties except Guyon's, and, thus far, prefer Bigelow's last model. Figs. 1244, 1245, 1246, and 1247, represent the Bigelow instruments, Fig. 1248 being the latest and best, the one he now advocates exclusively.

Bigelow's last evacuator (Fig. 1248) is an elastic rubber bulb, with a glass receiver and two stopcocks of metal. Within the bulb is the tube-strainer—a metallic tube, open at the end, and perforated with small holes crowded closely together over its entire surface. The bulb is worked by alternate compression and relaxation of the hand which grasps it. The fluid in the glass receiver is out of the way of the currents started by compressing the bulb. This is filled from above, and any air in it accumulates there out of reach of the aperture of the tube. The air may be easily discharged through the upper stopcock, and its place may be supplied by directly pouring water in or sucking it in through the coiled tube. The fragments of stone are drawn by suction through the evacuating catheter, the lower stopcock, and the open end of the tube. There are no valves, there is no stand, there is no rubber connecting-tube between the lower stopcock and the evacuating

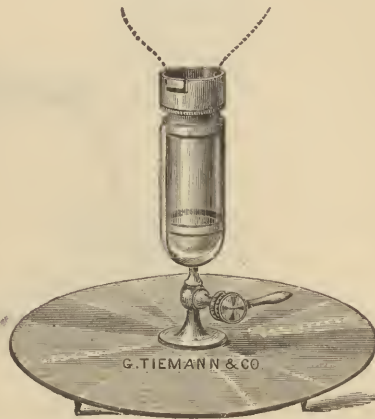
catheter. The rubber walls of the bulb are thick, and their elasticity and suction power great. The apparatus when coupled may be entirely freed from air-bubbles. The fragments are received at exactly the centre of the bulb and sink at once into the receiver. The return flow only moves the frag-

Fig. 1244.



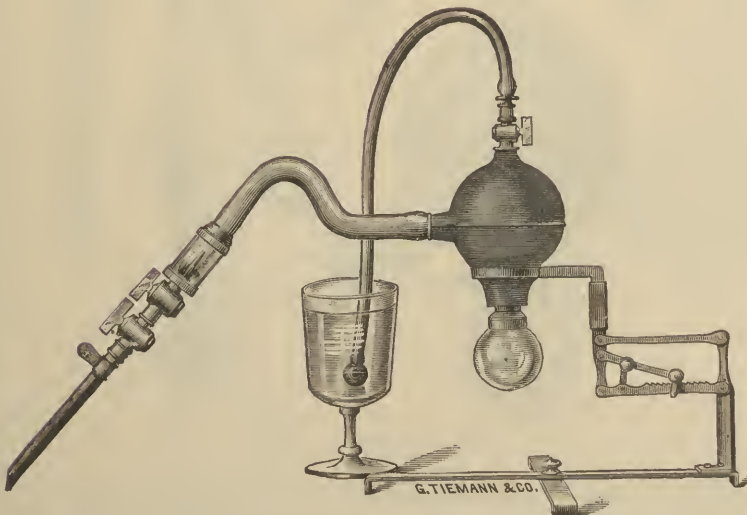
Bigelow's first evacuator.

Fig. 1245.



Stand for the evacuator.

Fig. 1246.

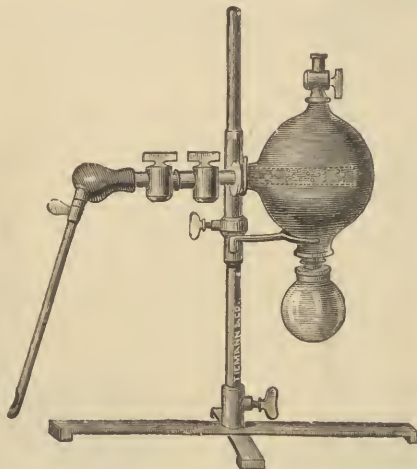


Bigelow's second evacuator.

ments which have last escaped from the tube-strainer and does not carry them to the bladder.

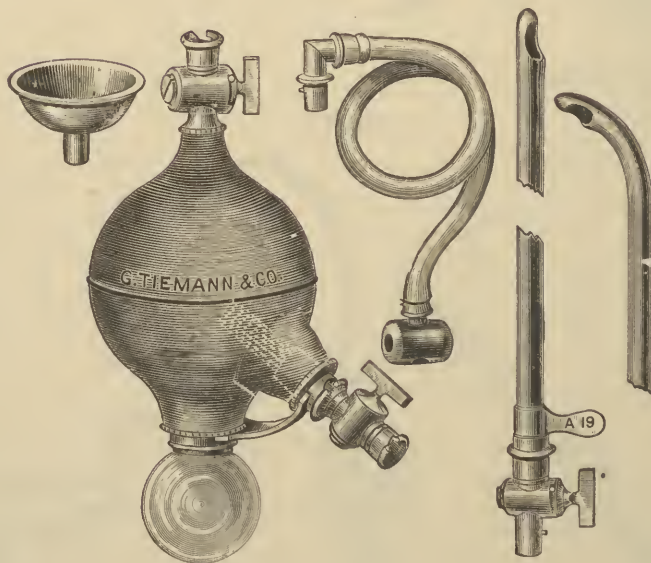
In the figure are certain accessories of the apparatus not essential to its use. The rubber tube fits at its angular metallic tip upon the upper stopcock of the evacuator, while the weighted extremity rests in a basin or pitcher of hot water; during the use of the evacuator, by means of the combination, air is expelled from the bulb or water thrown out or sucked in at will, to vary

Fig. 1247.



Bigelow's third evacuator.

Fig. 1248.



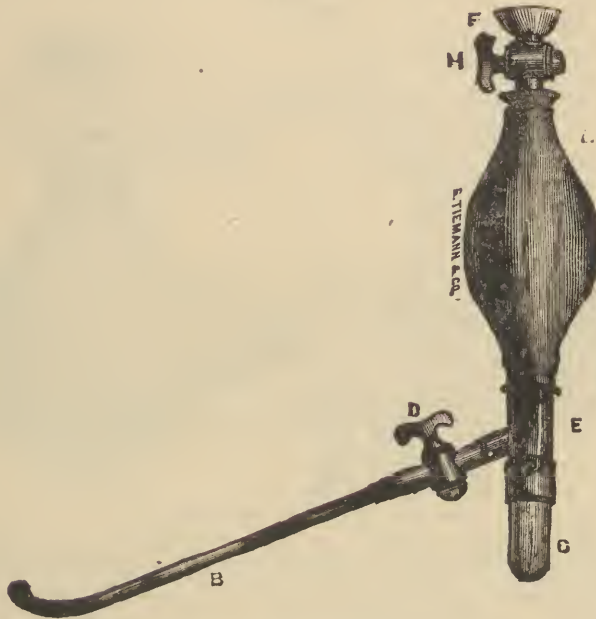
Bigelow's latest evacuator.

the amount of fluid in the bladder during the washing, the whole manœuvre being promptly performed by turning the upper stopcock and compressing

and relaxing the bulb. The metallic funnel is to substitute the tube in filling the evacuator through the upper stopcock.

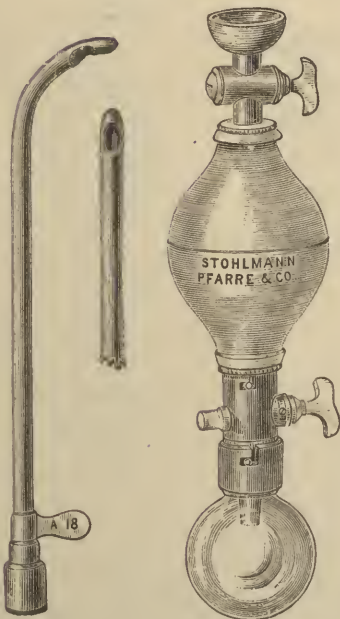
Operators who are familiar with the use of the tube seem to prefer it to

Fig. 1249.



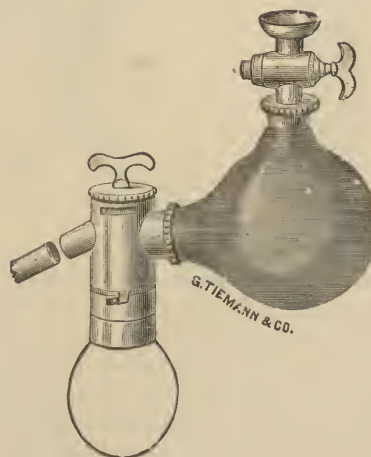
Thompson's first evacuator.

Fig. 1250.



Thompson's second evacuator.

Fig. 1251.

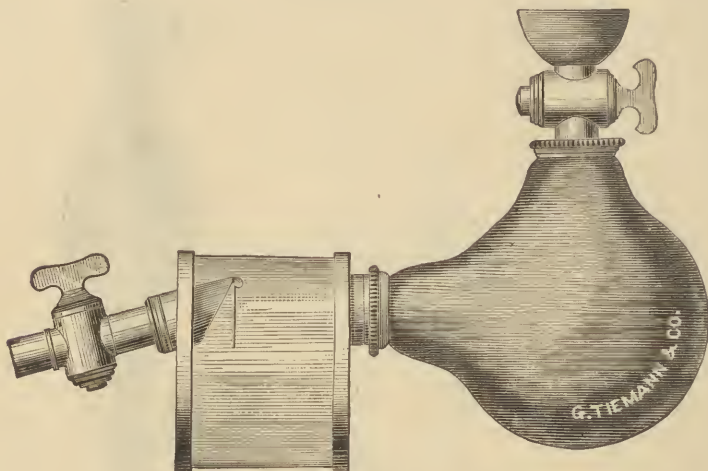


Thompson's third evacuator.

the funnel. The extra stopcock below is for use upon the evacuating tube before coupling, that air may not enter it.

Sir Henry Thompson's evacuator has also passed through four distinct stages. I represent them in the annexed figures, but only describe the latest.

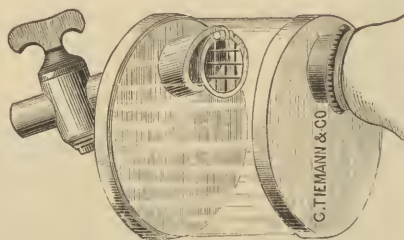
Fig. 1252.



Thompson's fourth and latest evacuator.

It is a rubber bulb, the central axis of suction of which is nearly in the line of the axis of the evacuating tube, but not as much so as in the case of Bigelow's instrument. The glass reservoir is situated in front of the rubber bulb, and a swinging, perforated valve hangs over the orifice of the tube, to prevent the return of fragments into the bladder.

Fig. 1253.

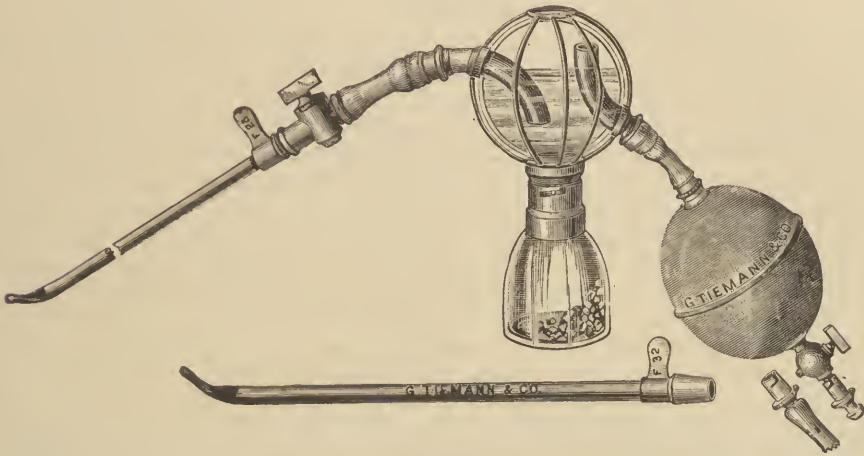


Reservoir of Thompson's evacuator.

Other evacuators, such as those of Hill, and of Corradi of Florence, I do not think it necessary to reproduce. Otis's evacuator involves a new mechanism, and as it is the first of its pattern it should be allowed opportunity for modification before it is judged, because each of its chief rivals has received several modifications before being given to the world as perfect. The figure sufficiently describes it. The sphere through which the tubes show is of glass, as is also the receiving bottle. The tubes, stopcock, and couplings are of metal, the power a rubber ball. It works without valves and delivers effectively. It is filled through a tube and stopcock at the tail of the rubber bulb, and may be worked with this bulb full either of air or of water. My objection to this instrument is that it is impossible to get the air all out of the glass sphere by any method of filling, so that although no air is thrown

back and forth into the bladder, yet the noise it occasions in the glass sphere prevents an accurate appreciation of the size of the fragments as they strike against the tube within the bladder. I find the instrument also less convenient in manipulation than the Bigelow bottle. It is a little cheaper than

Fig. 1254.



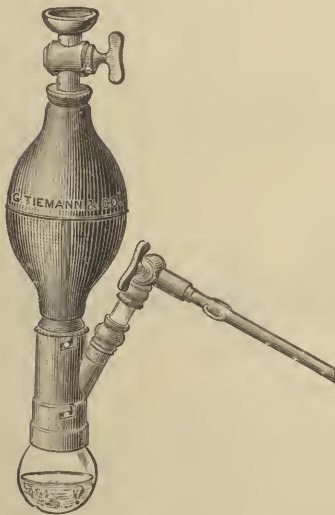
Otis's evacuator.

other instruments, and further modifications may bring it to that degree of mechanical perfection for which Dr. Otis's instruments are so justly celebrated.

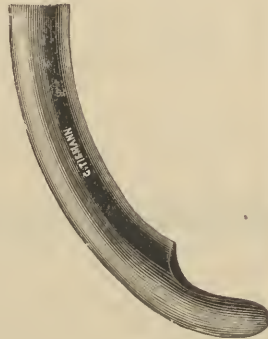
Fig. 1255.

Fig. 1256.

Fig. 1257.



Guyon's evacuator.

Curved evacuating
tube.Straight evacuating
tube.

Guyon's evacuator (Fig. 1255) should be referred to, since it has done so much good work. It does not commend itself as a mechanical triumph, but Guyon has proved that it is effective.

The evacuating tubes used in litholapaxy are curved and straight. Thompson and Guyon prefer the former, Bigelow the latter, but all lithotritists use either, as occasion requires. The tubes are made of thin metal, the eye so shaped as to scrape the urethra as little as possible on the way in or out, and, theoretically, not to catch fragments which are too large to pass the tube. The former end is attained very satisfactorily, the latter not so. I have not yet seen a tube with an eye which does not catch and hold fragments too large to pass the tube, and I have tried them all. Fig. 1256 shows the curved tube in profile. The straight tube (Fig. 1257) is identical as to its eye and its general construction with the curved tube.

These tubes are introduced as if they were curved or straight sounds, except that the straight tube may sometimes be twisted or rotated in through the fixed curve of the urethra where direct pushing will not succeed in making it pass. On account of the tendency of the eyes of all these tubes to catch fragments too large to pass through the tube itself, I have devised another form of straight tube, the eye of which cannot clog. When the eye of a tube does clog, if the fragment impacted in it is hard and angular, it may happen that water will not dislodge the fragment. No matter how forcibly the bulb is compressed, the fragment will stick in its place, and will be withdrawn with the tube, unless the operator is willing to uncouple the evacuator and push a solid stylet of some sort down to the extremity of the tube, while the end of the latter is still in the bladder. This manœuvre exposes the patient and his bed to a wetting, so that the surgeon is tempted to pull the tube out, charged as it is with a barb at its extremity.

I have seen the roof of the urethra quite sharply scratched on more than one occasion in this way. Once I saw a stone, so caught in a tube, drawn forward until it caught at the point of physiological narrowing of the pendulous urethra, in the third inch from the meatus. Here it stuck, and it was impossible to move the tube either way, or to dislodge the stone even with a solid stylet. Finally, by the exercise of very considerable force, the tube, still holding the stone, was dragged out—a manœuvre the reverse of surgical.

With the aim of averting any possible impaction of a fragment in the eye of the tube, I have used a straight tube of thin metal open at both ends (Fig. 1258). A wooden obturator makes its introduction reasonably easy, and

Fig. 1258.



Keyes's evacuating tube, straight.

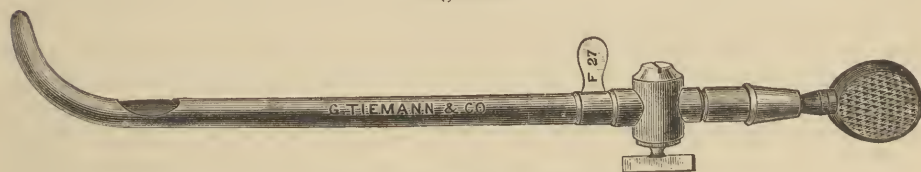
a washer on the obturator allows the latter to be withdrawn without leakage beyond the stopcock, which, being turned, keeps the bed dry until the washing bottle has been fitted to the tube. Such a tube in some cases renders valuable service, particularly in evacuating a last fragment, or in washing out a small stone recently descended from the kidney. Anything which once enters cannot fail to pass, and anything which lodges in its vesical opening will be immediately dislodged as the fibres of the vesical neck close over the tube during its withdrawal. It delivers very promptly to the washing bottle, but has this defect, that in order to make it functionate to its best advantage its vesical end must be drawn close down to the neck of

the bladder and held there. If it is pushed too far in, it does not return the wash properly, and the back wall of the bladder flaps inconveniently, perhaps painfully, against its open end, being drawn upon it by the suction of the evacuating bottle. On the other hand, if it is held close to the vesical neck the orifice of the tube may slip out into the prostatic sinus during the working of the bottle, and there bruise the membrane and fail to do its work. The tube therefore requires some care in its use, and for continuous work is not as valuable as those generally employed, but as an extra tube it has a function of its own, which I have found of value in shortening the operation.

Furthermore, in introducing the tube the operator must be quite certain that its tip has penetrated into the vesical cavity before he attaches the bottle, as otherwise, if he leaves the end of the tube in the prostatic sinus, he will wash in vain; I have known this accident to happen in able hands, and to produce a low opinion of this tube's value in the mind of the operator.

Finally, because a straight tube renders *débris* so much more readily than a curved one, I have had a curved tube made (Fig. 1259), with a large eye

Fig. 1259.



Keyes's evacuating tube, curved.

on its straight part, and a stopcock for protecting the bed from wetting while entering and withdrawing the obturator, which should always be used when the eye is very large, for fear of drawing out an impacted fragment. This tube is curved as far as introduction goes, but straight for all purposes of delivery. It works very well in my hands.

Joseph H. Warren has devised a spiral revolving tip, for attachment to the end of curved and particularly of straight tubes, in order to facilitate their introduction. Experience at my hands does not justify the claims made for this addition to the instrument.

As to size, Bigelow advocates the use of the very largest tube that will pass. Undoubtedly, the larger the tube the more satisfactorily does it render the *débris* to the washing bottle. But most operators rather shrink from distending the urethra to its utmost capacity, and use only as large a tube as the urethra will admit comfortably, perhaps after incising a bridled meatus. This is a sound rule to go by, and one generally followed. The meatus, if constricted, or with a pocket at its lower commissure, should be incised rather freely, and then as large a tube should be used as will go easily past the point of physiological narrowing in the third inch of the pendulous urethra, and nothing larger. This physiological point of narrowing almost invariably exists, and should not be cut or even over-stretched to accommodate a tube.

Perfectly effective work is constantly being done through tubes of moderate size. Thompson rarely goes above 16 English—27 French—and has smaller tubes for those who require them. Guyon uses about the same size. I have performed the whole washing, in an old man whose urethra I was particularly desirous of sparing, with a No. 20 (French) curved tube. The tubes I employ run from 20 to 32 (French).

MODE OF PERFORMING LITHOLAPAXY.—The patient having been prepared as already directed (page 784), is etherized and placed upon a table covered with a rubber cloth. The table should be high, narrow, and long. The patient lies upon his back, with the hips elevated a few inches above the table, the shoulders being low.

Two assistants are essential, one to administer the anæsthetic, the other to attend exclusively to emptying and refilling the washing bottle. It is well to have a third assistant to hand instruments, etc.

The first manœuvre is to introduce the curved tube selected for the operation, incising the meatus if necessary. Through this tube all the urine is drained away. Now the washing bottle, charged with a saturated solution of borax at 100° F., is attached to the tube. But the urine having trickled away in its last drops through the tube leaves the latter full of air, an element fatal to nicety of washing. This air may be disposed of most simply. The tube is withdrawn until its eye is in the prostatic sinus, the washing bottle is attached and the stopcock turned, but no further motion made. In an instant, the air contained in the curved tube is felt and heard ascending through the stopcock and mounting into the top of the rubber evacuator, where it does no harm, and whence it cannot possibly return into the bladder.

As soon as the rising bubbles of air have announced that the tube is full of water, the bulb is compressed, water distends the prostatic sinus and neck of the bladder, and the tube passes on almost unaided into the vesical cavity without damaging the neck of the organ. I have found this flushing manœuvre of great assistance in certain cases of enlargement of the prostatic third lobe. It is not necessary when a straight tube with obturator and stopcock is used, for in such a case the tube does not contain air. Now alternate contractions and relaxations of the rubber bulb are practised. This demonstrates the presence of the stone by the clicking noise made, while at the same time the wash disinfects the bladder. Two or three ounces of the fluid are left in the bladder, and the tube is withdrawn.

The next step is the crushing. This is done according to the rules already laid down for ordinary lithotrixy. All the seizures should be made deliberately, it being remembered that a cardinal rule of rapid lithotrixy is to work, if not slowly, at least with deliberation. No instrument should be used which can by any possibility clog. Seizures are made in prompt succession, no time being lost in clearing the blades. After a dozen or more successful seizures the lithotrite is withdrawn and the tube reinserted, with the precautions as regards the entrance of air already alluded to, and the washing commences.

The curved tube is first held so that its curve presses backwards and downwards upon the bladder behind the trigone. Then it is moved from side to side, and partly drawn out, finally inverted and held a little way up by depressing its distal end—the washing being kept up constantly as these changes in position are being made. The straight tube is held with its aperture as nearly as possible in the centre of the bladder, and preferably turned downwards; it also is rotated in different directions. The straight tube with an open end is so held that its opening lies just inside of the neck of the bladder.

The washing is performed by an easy succession of synchronous movements of the hand. When the fragments come into the receiver more slowly, and particularly to catch a last fragment, it is proper to compress the bulb rather violently, to maintain it compressed for an instant, and then suddenly to let up the pressure. When there is much angular débris the pieces rush together toward the eye of the evacuating tube, and, crowding into it, momentarily clog it, so that although they rattle most musically, there is very little show

in the receiving bottle. In such a case much better rendering will be effected by a succession of sharp, jerky, partial contractions of the bottle, so as to dislodge the accumulating fragments about the eye of the tube, only to stir up one or two, and to allow these to be sucked into the receiver.

Occasionally an angular piece of stone will clog the eye of the tube, not large enough to prevent a reasonably free passage of fluid, but effectually blocking the way to any fragments larger than dust. Now again, the fragments rattle about the tube, but the washing gives no return. An experienced operator always recognizes this accident at once; an unobservant one may lose much time before he finds it out.

When this accident occurs, a sharp gush of water sent suddenly through the tube will sometimes dislodge the fragment. Sometimes it will fail. Then the water should be drawn off, the tube uncoupled, and a solid stylet passed to drive out the fragment into the bladder. This is safer than to withdraw the tube with the stone impacted in it, although the latter course is the one usually adopted, and, as a rule, no harm comes of the slight scratching of the urethra which it occasions.

Often, as the tube is moved from side to side, and particularly when the curved tube is inverted, the bladder-wall flaps with a sharp click against the eye of the tube, and then flutters spasmodically with dull thuds against the open end of the instrument. This suction of the bladder-wall into the eye of the instrument has never been known to do any harm, but it must bruise the organ somewhat, and its repetition should be avoided by shunning the particular manœuvre which occasions it. When the bladder is empty, the sharp click given by the wall as it is sucked against the eye of the tube is often so hard in quality as to resemble the sound given by a fragment of considerable size. An operator not accustomed to the sound may be deceived in this way, and may go on indefinitely searching for a fragment which does not exist. Error may be avoided by noticing that the click may be produced at will by turning the tube in a given direction. A little experience teaches the operator all that can be known about this fluttering of the bladder.

Should air enter the bladder, it churns up the water needlessly, distends the bladder, and interferes with the efficiency of the wash, while it so confuses the sounds that the click of small fragments against the tube can no longer be clearly distinguished. To dislodge the air, the bladder should be fully distended, and then the handle of the tube strongly depressed between the thighs, so that its eye may be raised to the top of the bladder. While held in this position the rubber bulb is worked slowly, and the air escapes into the bottle, and remaining at its top can be discharged through the upper stopcock.

After the fragments cease to collect in the receiver, the operator removes the tube, and hands the bottle and receiver to his assistant, who immediately pours out the water, more or less stained with blood, empties the fragments, and refills the bottle. While this is going on the operator has again introduced his lithotrite, made a dozen or more seizures, and by the time the bottle is ready there is usually enough débris to call for another wash. In this way, by alternate crushings and washings, the fragments are steadily reduced in size and extracted.

SEARCH FOR LAST FRAGMENT.—A last fragment is sought for by auscultation during the process of washing. Every bubble of air is scrupulously removed from the bladder, and with a small tube—the bladder containing a little surplus of water, so that when the exhausting bottle is full the organ shall not be entirely empty—it is gently washed while the operator places

his ear directly over the lower part of the abdomen. The tube is turned in various positions and the operator listens. The swash of the water, as it rushes in and out, is heard with startling distinctness, and, if the management of the tube is skilful, any fragment of stone lying loose in the bladder is sure in a short time to be driven against the metallic tube and to announce its presence by a characteristic click, quite distinct from that emitted by the flapping of the bladder-wall against the eye of the instrument.

Fine sand and thin scale of stones make no sharp click, and all such may be left to pass by nature's efforts; but any piece large enough to require the lithotrite can hardly escape detection by the educated ear.

AFTER-TREATMENT OF LITHOLAPAXY.—This is practically the same as already laid down for cases of ordinary lithotripsy. No vesical washings are required unless retention comes on, or atony exists, or the urine has been highly offensive before the operation. In such cases borated washings comfort and purify the bladder.

The symptomatic treatment includes rest in bed, a hot-water rubber bottle for the hypogastrium—which is commonly the seat of pain—opium, quinine, sweet spirit of nitre, alkaline diluents, and mineral waters.

The sense of relief experienced after litholapaxy is often immediate and delightful. The patient exclaims at his comfort. Reaction may be very moderate, but it is not well to be too promptly reassured, since after a period of several days' calm, similar to what is noticed sometimes when an old case of vesical atony is for the first time relieved by the catheter, cystitis may set in and considerable distress be experienced. There may be retention of urine for the first twenty-four hours or more, or there may be none. There may be more or less urethral fever.

Generally, the urine ceases to be bloody from the second to the fourth day, and the patient may be up and about his room, or even out of doors, at the end of a week; but in any case, no matter how well he may feel, it is expedient to avoid risks and to keep him upon his back for about that period. He may arise to urinate, or to take a hot-bath—but should not sit up for any length of time. One of my patients, however, a gentleman of nearly seventy, after quite a severe operation, got up and took his cold sponge bath every morning without any evil result.

TIME CONSUMED BY THE OPERATION.—Bigelow operated continuously during upwards of three hours, removing seven hundred and forty-four grains, and his patient did perfectly well.¹ Thompson,² starting with a much shorter limit of time, now says that none of his calculi have required more than seventy minutes, this time having been required to remove a hard uric-acid calculus of which the débris weighed 1320 grains. The patient did well. Guyon's longest operation lasted seventy-five minutes. Reginald Harrison removed a two-and-a-half ounce stone in two hours and ten minutes,³ and Coulson, in an article⁴ reporting eleven cases with two deaths, says that his largest stone weighed 2060 grains, and was removed in three hours and a quarter. My longest operation lasted ninety-five minutes.

Therefore, it may be concluded that the element of time is not a very important factor in the operation, and while it is obviously better to terminate the sitting with reasonable promptness, the signal for stopping is the complete evacuation of the stone. Of course, any general circumstance which

¹ Am. Journ. Med. Sci., January, 1878.

² Lectures on Diseases of the Urinary Organs, 6th ed., p. 82. 1882.

³ Brit. Med. Journ., Aug. 10, 1882.

⁴ Lancet, March 19, 1881, p. 453.

would cause a surgeon to halt in the midst of any other operation, would weigh with equal, but with no greater force, here.

The amount of débris which may be removed in a given time varies greatly with circumstances. The average now is much higher than formerly, since operators have learned their power. The best recorded yield in washing was three ounces (dry weight) of small stones in twenty minutes—72 grains to the minute—a result obtained in Thomas Smith's celebrated case of multiple calculi. This result was obtained through a tube of size No. 27 (French). Bigelow's first set of cases yielded a little less than an average of three grains to the minute, while in a recent case¹ he removed successfully 1388 grains in one hour and fifty-five minutes, exactly 12 grains to the minute. Thompson's² first series yielded an average to the minute of $16\frac{1}{2}$ grains when the stone was hard, $12\frac{1}{2}$ when it was soft, while one of his later cases, that of the large stone already alluded to, gave him nearly 19 grains to the minute. My own first average³ was only $4\frac{1}{2}$ grains to the minute, while a recent case of hard phosphatic stone, 765 grains in 45 minutes, furnished me an average of 17 grains to the minute, and the patient did admirably, being up and dressed in five days. How much better may be done, time must determine, but no operator who values the safety of his patient should rank speed in the operation as highly as care and skill.

RELAPSE AFTER LITHOLAPAXY.—Relapse may occur after litholapaxy, as it does after lithotomy, a totally new stone formation taking place, but it cannot well occur otherwise if the precaution be taken to search the bladder carefully with a small tube and washing-bottle, after the patient has been up and about at his duties for a month or more. This manœuvre is so necessary that it might almost be termed the last step in the operation.

One thing only in the way of relapse cannot be guarded against by litholapaxy, or indeed by any operation, and that is *phosphatic re-accumulation*. In cases of chronic cystitis with atony, where the patient will not take intelligent care of his bladder, and in cases of encysted stone, or chronic pyelitis, and the like, phosphatic re-accumulation must and does occur.

Intelligence on the part of the patient may be required in these cases, and acuteness on the part of the surgeon to detect the cause of the phosphatic re-accumulation, and to do away with that cause if possible. But even in those cases in which the cause cannot be removed, the comfort furnished to the patient by litholapaxy, without risk to life, is far greater than could be afforded either by simple lithotripsy or by lithotomy.

Often when the cause of the phosphatic re-accumulation is chronic vesical catarrh, kept up by enlarged prostate and muscular atony, relapse after litholapaxy may be prevented by scrupulous attention to vesical irrigation, and by occasional injections of dilute nitric acid, of a strength varying from a few minims up to a fluidrachm, in a pint of warm water.

COMPLICATIONS DURING THE OPERATION.—These are injury to the urethra, injury to the bladder, hemorrhage, clogging of the lithotrite, breakage of a lithotrite, inability to introduce the tube, clogging of the tube.

The *urethra* is not likely to be injured by a lithotrite unless the instrument is withdrawn with its jaws impacted, or still containing a hard, jagged fragment. The *bladder* may very easily be injured to a varying extent by pinching up a fold of mucous membrane, with more or less of the muscular coat of the bladder, or even tearing it away in the grasp of the instrument. The

¹ Boston Med. and Surg. Journ., Dec. 29, 1881, p. 612.

² Lancet, Jan. 10, 1880, p. 44.

³ Loc. cit., p. 14.

resulting injuries are ecchymosis, contusions, excoriations, and lacerations of varying severity.

It is possible with any lithotrite to pick up a fold of the bladder, pinch it slightly, and then let it go. I have done this on the cadaver and on the living subject with equal ease with the instruments of Bigelow, Thompson, and myself. With the old-fashioned fenestrated lithotrite, having a cutting edge upon the male blade, this accident was fraught with danger; with modern instruments, managed with a little care, the accident is unimportant. In many cases it is impossible to perform litholapaxy without having the water, even of the first wash, distinctly tinged, sometimes positively darkened, with blood. This blood comes from the slight scratching injuries inflicted upon the mucous membrane of the bladder, and upon its neck, by the jaws of the lithotrite and the angular fragments of the stone. Such a moderate appearance of blood is a matter of course, and in no way compromises the success of the operation, or portends an outbreak of serious inflammation at its termination.

Hutchison, of Brooklyn, using a lithotrite of one of my earlier and imperfect models, reported that he pinched off shreds of mucous membrane from the bladder, but no reaction followed, and "the result was satisfactory." Wynkoop, of New York, using one of the earlier Bigelow instruments, found the jaws to clog, and had to use much force in extracting the blades. The clogging appears to have been due to some mechanical defect in the construction of the instrument; abscess ensued from laceration of the deep urethra, and the patient was subsequently cut for removal of the remains of the stone and for cure of the abscess, and recovered. In another case treated by the same operator, in which also Bigelow's lithotrite was used, the patient died twenty-nine hours afterwards, and at the autopsy a number of abrasions and minute lacerations of the mucous membrane of the bladder were found. Hence, it may be assumed that a certain amount of scratching damage to the bladder is commonly produced by all lithotrites, but that, as a rule, such moderate damage does no harm. It need hardly be added that the less damage done, the better, and that, other things being equal, the better the operator, and the more perfect the instrument, the less will be the physical injury inflicted upon the bladder. On two occasions in former years I have, while practising the old operation, pinched off small shreds of mucous membrane from the bladder—once, in fishing for a soft catheter in a paralyzed bladder, the patient denying any sensation when the thin film of mucous membrane was seized, and once in working rapidly with an instrument which it was believed would not clog and could not catch the bladder. In neither of these cases did the least reactionary disturbance hinder the recovery of the patient, or indicate that any unusual damage had been done.

In a case where a suit for malpractice was instituted in New Hampshire, one of the lawyers informed me that an irregular practitioner had passed the lithotrite but had found no stone. After considerable search, another surgeon who was present introduced his finger into the rectum, and there found the jaws of the lithotrite which had passed through the membranous urethra. The wound healed, and the patient recovered.

My personal experience¹ has led me to conclude that damage done to the urethra by a clogged instrument, or by the use of tubes too large for the canal, is more likely to be followed by disastrous results to the patient than similar or even greater damage inflicted upon the bladder. Much damage can be done to the urethra as well as to the bladder without serious consequences, as will be shown when speaking of the clogging in lithotrites and impaction in tubes. In any case, it is only just to the patient upon whom

¹ Am. Journ. Med. Sci., April, 1880.

litholapaxy is performed to use a lithotrite which will not clog, to operate with all possible care, to employ tubes which do not stretch the canal too decidedly, and to dislodge impacted fragments before withdrawing the tube.

Hæmorrhage during litholapaxy commonly occurs to a moderate degree, but the final wash, usually, is hardly, if at all, bloody. In some cases, on the other hand, the hæmorrhage is profuse from the very first introduction of the lithotrite. I have had a case in which, on introducing the tube, pure blood flowed out, and only stopped after coagulation within the tube had made a plug large enough to occlude it. This plug was drawn out as a complete, long cast of the tube. The bleeding did not continue uniformly at this rate, and the washing was successfully followed up, but the amount of blood lost made it necessary to arrest the sitting before all the débris had been removed. Ten days subsequently the remaining two drachms of fragments were successfully removed, the remarkable fact being that on this occasion the amount of hæmorrhage during the operation was exceptionally small. The patient was 75 years old; the stone weighed 513 grains; recovery was prompt and complete.

In a case of hæmorrhagic diathesis, or if the bladder happened to contain a villous growth along with the stone, very serious hæmorrhage might occur. I am not aware that any case thus far has been reported in which a fatal result after litholapaxy has been ascribed to hæmorrhage. Ultzmann, however, has expressed the fear that serious, even fatal, hæmorrhage may result from the operation.¹

Clogging and Breakage of the Lithotrite.—The lithotrites commonly in use at the date of introduction of litholapaxy were of two kinds, both dangerous. The fenestrated lithotrite had a cutting edge along both sides of the male blade, and the male blade fitted snugly into the fenestra of the female blade. With this instrument, if the bladder was seized at all, a piece was quite certain to be cut out. The bladder could not be pinched and dropped, and consequently the fenestrated instrument was used only on rare occasions and with special care, when a very hard, large stone had to be fragmented into large segments preparatory to final pulverization.

The danger of using the instrument freely was well known, and was expressed by Thompson before the Royal Medical and Chirurgical Society of London, March 16, 1878, when he said that he had not used a fenestrated instrument in the bladder for ten years.

The non-fenestrated, pulverizing lithotrite would not readily catch the bladder or harm it much, if it did pinch up a fold; but it had its own especial danger in that it was quite sure to clog with débris after a few seizures had been made, and that it was generally next to impossible to free the blades when once they had become firmly impacted at the heel of the jaws. Consequently it was taught that, after from three to six successful seizures, the instrument must be removed and its jaws disorged, to avoid inflicting serious damage upon the urethra.

In fact, at the meeting of the Royal Medical and Chirurgical Society, already alluded to, both Thompson and Coulson laid great stress on this impaction as sometimes "preventing the withdrawal of the instrument," and as having required, "in one case, incision in the perineum."

With such instruments, manifestly, litholapaxy could not be properly performed. But since the introduction of the new operation a number of lithotrites have appeared whose claims consist in three elements: (1) strength; (2) blunted roughness and lateral bevelling of the male blade, so that the bladder, if caught, need not be seriously damaged; (3) fenestration, with a

¹ Centralblatt f. Chirurgie, No. 24, S. 393. 1882.

large spur at the heel of the male blade, and comparative breadth of the female blade, to insure against impaction.

I have already recorded the impaction of a Reliquet instrument in my hands while performing old-fashioned lithotrity. In litholapaxy this accident has not occurred to me, and with the instruments which I now use, it is impossible.

Coulson, at the meeting of the International Medical Congress, in London, stated that on two occasions a lithotrite had broken in his hands. One of these cases was reported in the *Lancet*.¹ The instrument was a Bigelow lithotrite, defectively made. The collar holding on the male blade came off. The jaws had to be freed from débris by percussion, after which the lithotrite was withdrawn, no harm being done, and the operation was concluded with a fenestrated lithotrite.

Several cases of slight clogging of some of the earlier Bigelow instruments, due to defects in structure, have been reported (Wynkoop, Stein).² One of my lithotrites, of Tiemann's make, in the hands of Dr. Rockwell, of Brooklyn, broke at the heel of the male blade upon a large oxalate-of-lime stone which was too hard to be crushed. The patient was cut at once successfully. I was present at an operation at the hands of Dr. Weir, when a Bigelow lithotrite broke at the collar under exactly similar circumstances. The patient was then cut, and successfully relieved of a large oxalate-of-lime stone.

Alan P. Smith³ reports a case of serious clogging of a lithotrite in the bladder of an old man. The instrument was of the Civiale model, made by Robert and Collin. After it had clogged, no efforts made at the handle could free the jaws, and consequently the instrument was forcibly extracted, when it was found that the jaws were separated to the extent of three-fourths of an inch; yet no evil result followed in this case.

Agnew,⁴ of Philadelphia, refers to one instance in his knowledge, where a lithotrite could not be closed on account of some defect in the button which regulated the screw. As a consequence of withdrawing it with the blades apart, injuries ensued which proved fatal.

Should an instrument clog badly, it seems to me that it would be proper to cut the patient at once by the median section upon the lithotrite, dilate the neck of the bladder, and bring out the jaws of the lithotrite in the wound of the perineum, where they might be cleared. Such a course would be devoid of any considerable danger. If the jaw of a lithotrite should break within the bladder, it might be extracted by using a smaller lithotrite, or the knife might be resorted to with propriety.

COMPLICATIONS OCCURRING AFTER LITHOLAPAXY.—After litholapaxy, the same complications may arise as have been already set down as possible after lithotrity (urinary fever, retention, hemorrhage, cystitis, epididymitis—or even surgical kidney, possibly pyæmia, septicæmia, etc.—graver complications which will be considered under the head of complications of lithotomy). There is not, however, as much likelihood of complication after litholapaxy as after lithotrity, because the former operation is devoid of one great source of danger, namely, that arising from the repeated injuries inflicted upon the bladder by the sharp fragments left behind between the sittings.

The slighter complications are not uncommon (urinary fever, mild cystitis, epididymitis); the others very rare. The complications most to be dreaded are pyelitis and surgical kidney, due to already diseased kidneys, and failing vitality in an old patient, when the risks of an operation have been assumed

¹ *Lancet*, Nov. 27, 1880, p. 853.

² *Maryland Medical Journal*, January 2, 1882.

³ Keyes, *Am. Journ. Med. Sci.*, April, 1880.

⁴ *Op cit.*, vol. ii. p. 661.

rather than the prolonged endurance of the certain torture and slow death which would have followed had no operation been performed. I have not seen atony of the bladder follow litholapaxy, nor heard of it.

Thompson¹ speaks also of chronic cystitis with phosphatic deposits as coming on in some cases as an after-complication of litholapaxy, when it did not exist before the operation. The same complication has arisen in his hands after lithotomy. He says further, that "one of the most persistent examples of phosphatic cystitis" which he has seen of late years followed an operation of rapid lithotrity done two years before, in which he removed with great ease in six minutes a small uric-acid calculus weighing 84 grains. He refers also to five other cases in which there was more or less chronic cystitis prolonged for a period of several months, in all of which "the calculus was uric acid, and cystitis was not present before the operation."

When this complication occurs, it is to be met according to the general principles governing the conduct of a case of chronic cystitis with tendency to phosphatic accumulation.

APPLICABILITY OF LITHOLAPAXY TO WOMEN AND CHILDREN, AND FOR THE REMOVAL OF SUBSTANCES OTHER THAN URINARY DEPOSITS.—The applicability of litholapaxy to children has already been considered (page 779). Females of all ages are admirably suited for the operation. I have employed it at both extremes of life.

Generally, the known existence of any substance in the bladder other than a urinary concretion, has been looked upon as a bar to the crushing operation, but with strong instruments and large tubes, certain exceptions must now be made. Pieces of bone, wood, wax, lead-pencil, slate-pencil, pipe-stem, or catheter, known to be acting as nuclei of stone, may be disregarded, crushed up, and washed away with the rest of the débris. I was present at an operation at the New York Hospital, in which Dr. Peters removed with some phosphatic débris quite a large piece of wax. Bigelow, in his first set of cases, removed a portion of catheter which was the nucleus of a stone. I have done the same. Holt C. Wilson² has quite recently reported a case in which he removed successfully by litholapaxy, from a patient of 42, a phosphatic stone and six inches of an English web-catheter, of size No. 8 (No. 15 French).

LITHOTOMY.

Lithotomy, like so many of the surgical terms which have been consecrated by usage, is a misnomer. We no longer cut the stone, as history tells us was done by Ammonius, but we cut the soft parts, more or less, and extract the stone whole, or after it has been broken.

The first known attempts at extracting stone from the bladder of the male seem to have been made long before the Christian era by the Hindoos. Doubtless, the idea first suggested itself to some one who witnessed the spontaneous expulsion of a calculus through the perineum, or perhaps liberated a large stone from a perineal fistula by a stroke of the knife. Certain it is, that the operation known as "cutting on the gripe"—the *apparatus minor*, as it was afterwards called on account of the small number of instruments required for its execution; also christened the method of Celsus, on account of the accurate description which that writer gave of the operation in the first century of our era—was the earliest ever performed, and that in spite of its rudeness and manifest imperfections, this, more or less modified, was

¹ Op. cit., 6th ed., p. 94.

² Med. Record, Dec. 23, 1882, p. 709.

the prevailing method of extracting stones from the bladder during twenty centuries.

The description of the Indian method of cutting on the gripe is essentially the same as that of Celsus. The latter only advises the operation for children between the ages of nine and fourteen; afterwards it was used for patients of all ages, but it was recognized that the older the patient the more uncertain was the closure of the wound. Albucasis formulates this conclusion, and says that under fourteen years healing is easy.

The rude manœuvre of cutting on the gripe consisted essentially of three steps. First, some effort was made to cause the stone to fall toward the neck of the bladder by striking the shoulders, shaking the patient, and pressing upon or stroking the abdomen which had been previously greased. The second step was to hook the stone down by putting one or two fingers into the anus, and assisting the descent by the pressure of the hand of an assistant upon the hypogastrium. Meantime, the patient was held firmly by the arms and legs upon the lap of a strong assistant (or two of them, sometimes with one more at each side to steady the group), leaning back upon his breast. An incision was now made, generally with a broad knife cutting at both edges near the point, upon the stone as it bulged in the perineum. This incision, as described by Celsus, was usually curved transversely above the anus, each horn of the incision looking outwards and backwards. But incisions of other shapes were also made transversely, curving upwards, and on either side, until finally it came to be the proper thing to make the incision upon the left of the raphe, curving outwards, the convexity of the incision looking towards the anus. Velpeau ascribes to Antyllus the left lateral incision.

The third manœuvre was the extraction of the stone. Sometimes it was forced out by the pressure of the fingers behind it, but more often it had to be extracted with hooks, forceps, and the like, or cut with some special instrument to facilitate its removal—as practised by Ammonius. Various means of washing out the bladder and cleaning it of any remaining débris were afterwards introduced.

This operation must have counted many successes, for it continued to thrive, passing through the hands of travelling specialists to find champions for its defence long after its more surgical rival, the Marian operation, had appeared upon the field. The neck of the bladder was probably not often cut into at all by most of the surgeons who cut upon the gripe, although it was the aim of the deep incision, as recommended by Celsus, to cut across the neck of the bladder transversely. The bladder-wall itself and the back part of the prostate were incised by most operators, and the seminal vesicle and ducts of the left side were very constantly cut through.

There grew to be a prejudice against cutting into or across the middle line of the integument, or approaching the rectum—a prejudice which continued active after the introduction of the grooved staff by Marianus—on the ground that if the raphe were cut it would not heal, by reason of the callosity of the tissues there, and that fistula would be quite certain to follow; and that if the hemorrhoidal vessels near the anus were opened, very dangerous or fatal bleeding would result.

The *apparatus major*, the conception of which has been ascribed to the Italian surgeons Battista da Rapallo and Joannes de Romanis, was first publicly described by the pupil of the last-named surgeon, Marianus Sanctus, in 1524. Whereas almost no instruments had been required for the older operation, this one was burdened down by machinery. The essential advance made by this operation, from a surgical standpoint, was the introduction of the *itinerarium*—the guide to the neck of the bladder—the grooved staff upon which the incision was to be made.

Marianus did not, however, cut into the neck of the bladder. He counseled strongly against it, asserting that a division of the constricting muscles of the bladder would be unavoidably followed by incontinence of urine. The operation was essentially an incision in the left side of the perineum upon a grooved staff; by some operators it was made upon the extreme right. The urethra was opened to the breadth of the nail of the thumb, and the parts beyond were dilated and torn rudely with rough instruments. Sometimes the stone was broken before extraction. Joannes de Romanis advocated this modification, but Marianus objected to it. Extraction was effected by forceps and scoop.

Ottavien da Villa, a pupil of Marianus, came to France and communicated his method to the surgeon Laurent Colot, and Henry II., in 1556, created for the latter the position of Court Lithotomist. The Colot family retained the secret, and practised lithotomy as specialists for more than a hundred years, and it is related that in the seventeenth century the secret was stolen from Jerome Colot (who died in 1684), by some ambitious surgeons who bored through the ceiling of the operating room at La Charité, in order to watch the great operator at his work. They were not a little surprised and disgusted to find that the operation so long kept secret, was only a slight modification of the apparatus major of Marianus, which was every-where known.

Thus it appears that the apparatus major was essentially urethrotomy with dilatation of the neck of the bladder and extraction of the stone, often after it had been broken, an operation which in our own day has been slightly modified, but much improved, as the perineal lithotomy of Dolbeau.

After the adoption in the apparatus major of the staff, or *itinerarium*, all sorts of variations in the incision, external and internal, began to appear. Franco sustained the prejudices of his time, and feared to cut the raphe. His mind was actively occupied with devising better means for penetrating the bladder. He even suggested the use of a double cutting instrument resembling the double lithotome, which was then in use for enlarging wounds. With this he proposed to incise transversely the neck of the bladder, although there is no evidence to show that he ever actually did it. To Franco is ascribed remotely the origin of the lateral operation, somewhere near the middle of the sixteenth century, although to Frère Jacques undoubtedly the distinction more properly belongs. Franco, however, certainly did discover the *supra-pubic* operation, and described it quite graphically in 1561.

He was at that time cutting habitually in the perineum, when it happened to him to be called upon to extract a stone as large as a hen's egg from an infant two years old. He cut in the perineum and vainly tugged at the monster stone, but was unable to get it out, and then, actuated by the solicitations of the parents and friends, who wished their child to die rather than suffer longer—and driven to it, as he himself confessed, by a false pride, lest he should be reproached with having been unable to get the stone away—he cut the child over the pubes, and the infant recovered.

Attempts to fix the origin of the supra-pubic operation at a date earlier than this have failed, and historians now generally agree in giving Franco the credit of the origination of the operation in 1560.

In 1581, Rosset first described a regular operative method of reaching the bladder by cutting above the pubis, but he never practised it; and although occasional cases are recorded, or alluded to (Piètre, Colot), and although there was considerable discussion about the operation, it was not until Frère Côme, with his "sonde à dard" and other accessories (12 in all, which he considered essential to the proper performance of the task), had operated a number of times between 1758 and 1779, that the operation took veritable shape. Frère Côme's operation has been the one commonly employed up to a late date.

Much discussion relative to the high operation occurred among surgeons in the early part of the present century, and more favor came gradually to be accorded to it. Cheselden performed it, before finally adopting his perfected lateral operation. Souberlielle became its champion in 1840. Vidal (de Cassis), in 1852, made a modification by doing the operation in two sittings, to avoid infiltration. Valette, in 1858, attempted to operate by cauterization; Chassaignac, and afterwards Tisseire, tried the *écraseur*. Baudon made a special study of suturing the vesical walls. Petersen, in Germany, Poland, in England, Guyon, Monod, and Périer, in France, and Dulles, in this country, have of late years been its warm advocates. Van Goudoever, in a communication made to the Medical Congress at Amsterdam, in 1879, made a strong plea for the operation in the case of infants, and Petersen,¹ of Kiel, by the introduction of the rectal colpeurynter, as one of the steps of the operation, and Guyon,² of Paris, by further modifications, have given a still stronger impetus toward a resuscitation at home and abroad of the old operation of Franco.

It has not yet been made clear, however, by statistics or otherwise, that the operation is a good one for any cases except those of adult men with very large or encysted stones, or with vesical tumors of large size, and for the extraction of certain foreign bodies. If it is a good operation for general adoption in all cases that are to be cut, the point has not yet been proved. Dulles, its chief advocate in America, has not, as far as I can learn, recorded any operation of his own. His advocacy seems to be based upon reasoning. E. Bouley, in a monograph of 260 pages (Paris, 1883), gives an excellent historical sketch of the operation.

The *lateral operation* dates its definite existence to Jacques Baulot, commonly known as Frère Jacques, the greatest of all the itinerant lithotomists. He was born in 1651, and entered the army as a common soldier at the age of sixteen. Here he encountered a travelling lithotomist named Pauloni, and followed him for about six years, assisting him in his operations. Then Jacques set up for himself and had a most notable career. He adopted a monastic garb in order to distinguish himself and gain more power over the people, but he never made any pretensions to being a monk, although he accepted the appellation "Frère." He went to Paris in 1697, being at that time 46 years old, and possessed of considerable reputation in the provinces. His instruments were simple—a large staff without groove, a long pointed bistoury, a dilating conductor, and a heavy pair of rough forceps. His early work in Paris was varying in its success, until finally, in 1698, he was selected to do the spring operating at the Charité Hospital. He cut 60 patients: 23 died, 24 remained in the hospital with incontinence, fistula, or other serious disorders, while only 13 recovered. The ordinary death-rate in that day was about 1 in 7, by the common operation as practised by surgeons generally, and therefore Jacques, covered with confusion, yielded to the public condemnation and left Paris. He now, when 48 years old, began to dissect and to study under Fagon, at Versailles, and made such good progress, adopting the grooved sound, etc., that in 1701, at Versailles, he cut 38 patients consecutively, and with success in each instance. In 1702, he published his method in pamphlet form, and in 1704 was lauded on all sides, loaded with testimonials, and fêted in every quarter; portraits were made of him, medals were struck off, gold sounds were given to him, and various other demonstrations were made of his wide-spread popularity. He died in 1714.³

¹ Langenbeck's Archiv, S. 572. 1880.

² Ann. des Mal. des Organes Génito-Urinaires, Déc. 1882, p. 1, et Janv. 1883, p. 97.

³ These details, and many other facts in connection with the history of lithotomy, are taken from Chauvel's masterly article, "Cystotomie," in the Dictionnaire Encyclopédique des Sciences Médicales.

Rau, in Holland, operated very successfully. In 1713 he said that he had cut 1547 patients. He operated by what is believed to be have been the lateral method, but no exact record of it has been left. He said in his lectures to his pupils, "Since I am obliged to live and gain my sustenance mainly by the employment of this method, I will not describe it to you at all. If I were forced to tell you something about it, that which I would tell you would not be the truth, wherefore I prefer to maintain absolute silence. If you can learn my method by seeing me operate, I have no objections to make, but, for the rest, read Celsus."

At about this time, early in the eighteenth century, Cheselden began to remove stones from the bladder by the supra-pubic operation. Until this time most of the English lithotomies had been according to the apparatus major of Marianus Sanctus. Cheselden, having heard of the success of Frère Jacques, tried the perineal operation, but promptly lost four out of ten patients. This stimulated him to new efforts. He studied the subject profoundly, and finally reached the perfected lateral operation, performing it in all its essentials as it is done to-day. His fame spread abroad to such an extent that, in 1729, the French surgeon Morand was sent by the French Académie des Sciences, at the expense of that institution, to study the method of the distinguished Englishman in London.

No notable modification of the lateral operation has been made since the days of Cheselden. A vast number of minor innovations have sprung up, but nothing fundamental. The main trouble has been to get uniformity of opinion as to the extent of the internal incision, and in order to make this a matter of mathematics two instruments have appeared in the field, the cutting gorget and the concealed lithotome; the former cutting from without inwards, a distance regulated by its breadth, and the latter cutting from within outwards, to a depth regulated beforehand by the distance to which the point of the concealed knife is allowed to protrude from its sheath.

The first *cutting gorget* was one of the instruments of the apparatus major. Its edge was sometimes sharpened that it might cut the prostate, but blunt instruments were generally used to effect dilatation of the vesical orifice. Presently innumerable gorgets, blunt and sharp, single and double, of various curves and shapes, were devised, each operator seeming to have his favorite. These have nearly all become obsolete except the blunt gorget, which Thompson still recommends to be used as a guide for the forceps in the case of a deep perineum, in fat men with large prostates.

The *lithotome caché* was given to the profession through the columns of the Journal of Verduin, in 1748, by its inventor, Jean Bascilhac, better known as Frère Côme. This instrument is still in general use in France. It has been abundantly modified, but not as extensively as the gorget. Dupuytren's double lithotome caché, with which he performed his bilateral operation, is perhaps the best known of the modifications.

In the line of the cutting gorgets and lithotomes belong the triangular blade of Civiale, to be pushed along the groove of the conductor, and the broad probe-pointed knife of the late N. R. Smith, of Baltimore. Cosaccio, in 1847, devised a deep gutter to replace the groove of the sound, in which gutter the point of the cystotome could glide, but from which it could not escape. Numerous similar sliding cystotomes have been devised since that date. One very well known in New York, is the bisector of the late James R. Wood.

Most English and American surgeons use the scalpel or the Blizzard knife with which to incise the neck of the bladder, preferring it to any cystotome, lithotome, or gorget.

The *bilateral operation* is only a modification of the lateral; the original

operation of Celsus was bilateral, the external incision being transverse, with the curved ends of the incision looking backward, while the aim of the internal incision was to divide the neck of the bladder transversely. Chaussier and B  clard both had the idea of a double lithotome, and the latter in 1813 had such an instrument constructed, but he did not use it upon the living subject, and to Dupuytren, in 1824, belongs the credit of having formulated and executed the bilateral operation as it exists to-day.

The *median operation* dates back into the age of the apparatus major, where operations were done on one or other side of the raphe (para-rapheal). The deeper incisions have been variously modified, as in Civiale's medio-bilateral method, but the median operation as practised to-day was first performed early in the present century by Manzoni, of Verona; afterwards by Borsa and Rizzoli, also in Italy; and more lately still by Allarton, in England. Markoe has been active in his efforts to introduce it in this country. It has achieved a distinct position among the recognized operations of lithotomy.

The *medio-lateral* (Raynaud, 1824) and *medio-bilateral* (Civiale, 1828) were special operations which have not created for themselves any fixed position, while the quadrilateral cystotomy of Vidal (de Cassis), 1828, has fallen into entire and well-merited oblivion. The same may be said of the attempt to perform lithotomy with the thermo-cautery, introduced not long since by Mallez, and employed several times by him. Verneuil and Anger both tried it for the superficial incisions, and in this country, on one occasion, L. A. Stimson. The manoeuvre has no merit to recommend it, and many disadvantages.

Recto-vesical lithotomy remains to be considered. This is an operation which no longer finds a place in most text-books, yet its claims deserve notice in a historical way. In 1817, Sanson proposed two operations through the rectum; one above the prostate, through the trigone; the other through the body of the prostate and neck of the bladder. The operation in either case is easy. The lower fibres of the rectum are cut in the middle line, upon a sound previously passed, and having a central groove. Then the bas-fond is perforated, or the urethra just in front of the apex of the prostate, and a central incision is made along the groove of the sound, through the prostate in one case, one inch backward through the trigone in the other. A large stone may be readily extracted by this method, but difficulties in the way of closing the wound result. The operation has been nowhere received with general favor. One of its strongest defenders was Vacca Berlinghieri, in Italy, who divided a portion of the perineum as well as the rectal wall. Death or permanent rectal fistula has been found to be so constant a sequel of the recto-vesical operation, that it has, at the present day, few if any advocates. Section of the ejaculatory duct is a matter of necessity in the prostatic variety of this operation. The substitution of the   craseur for the knife did not enhance its value.

Sims proposed direct section of the bladder behind the prostate, and immediate application of metallic stitches. Schaeffer formulated rules for the performance of the operation and for subsequent suture, using the latter both for the method involving the prostate and for that interesting the trigone. He employed thread coated with rubber, instead of silver. No efforts have succeeded in establishing rectal lithotomy as a justifiable operation. Its statistics are worse than those of the high operation, with the additional disadvantage that, among those who recover, a certain proportion retain permanent fistulous communications between the rectum and the bladder or the urethra. A recent effort has been made by Bauer, of St. Louis, to advance this operation into general favor by detailing a case of recto-vesical lithotomy in

which he used silver sutures. The case did not do very well. Bauer refers¹ to a former operation done by himself, in 1859, and to the *trigonum section*, described in 1881 as a new operation by Muehlhäuser, of Speier. Gross² refers to a case in which Bauer extracted a stone and got a good result by the use of five wire sutures, but gives no reference. He also says that Noyes, in 1860, made a central prostatic incision, enlarged it bilaterally within, and got a good result with metallic sutures.

Maisonneuve proposed a form of rectal lithotomy in which the membranous urethra was opened through the rectum, and the prostate and neck of the bladder approached with a double lithotome through the rectal wound. It has found no favor. Malgaigne attempted it four times. He lost two patients, one retained a recto-urethral fistula, and only one recovered.

GENERAL CONSIDERATIONS CONCERNING LITHOTOMY.—The history of lithotomy shows that all efforts to reach the bladder by the knife have been made through regions containing parts the wounding of which was not considered mortal. The track leads always through the perineum, over the pubic symphysis below the peritoneum, through the rectum (or the vagina in the female), attacking the organ where the peritoneum does not cover it. The rectal operations have been condemned by general consent. The vaginal operation is in full favor for women.

For the male there remain two sets of operations, the one approaching the bladder through the perineum, the other above the pubis.

Of the perineal operations there are in reality but two, the lateral and the median. The other methods are only modifications, the bilateral and pre-rectal forms of external incision, the bilateral division of the prostate. Such special methods as those of Buchanan, Key, Smith, Wood, and others, are only varieties of detail in executing a method—not special methods. The median external incision receives modifications (medio-lateral, medio-bilateral) according to the incisions made in the prostate. Again it is modified in what is known as perineal lithotrixy.

The high operation is always made nearly in the same way, the variations being largely as to the opening in the bladder and the question of sewing it up.

SELECTION OF A METHOD IN LITHOTOMY.—In considering the question of lithotomy relatively to a given stone, it is proper to ask what operation should be selected. In former days, and even now, an operator often selects a favorite method and submits all the patients whom he cuts to it. This is manifestly unjust; unfair to the method, unfair to the patient. All operations have something in their favor, none of them are without the reproach of having defects under certain circumstances, and, although undoubtedly an operator grows more and more familiar with an operation which he has often performed, and does it better than he would another, yet it is manifestly his duty to familiarize himself reasonably with all operations, so that his resources during an emergency may be ample.

Now, a stone is small, medium-sized, or large. Thompson's dictum is generally accepted on this subject. A medium-sized stone is one which averages not more than an inch each in two of its diameters. Thus a stone two inches long or longer might appropriately be styled a medium-sized stone, as far as the practicability of its removal by the cutting operation was concerned, if its two broad diameters averaged about an inch each.

¹ St. Louis Med. and Surg. Journ., 1870; and Archiv f. klin. Chir., Bd. xxvii., S. 180. 1881.

² System of Surgery, 6th ed., vol. ii. p. 758.

Anything beneath this medium size is a small stone, and anything above it is a large stone.

The very careful dilatations of the prostate and neck of the bladder made experimentally by Dolbeau with his ingenious dilator, have shown that the neck of the bladder cannot be distended to a diameter greater than 20-24 millimetres without the production of organic lesions of the prostate and vesical neck. These lesions are single and large, or multiple and small, radiate lacerations, extending more or less deeply. Dolbeau's experiments I have repeatedly verified upon the cadaver. Twenty-four millimetres is just short of one inch; therefore manifestly no stone an inch in diameter, more particularly when surrounded by the blades of the forceps, can pass the neck of the adult bladder without determining physical lesions by laceration. I have seen a stone nearly two inches in diameter dragged through the uncut vesical neck in the median operation, by a surgeon who was obliged to use all his force in order to extract it. The patient recovered, but the exhibition was the reverse of surgical.

Lacerations of the neck of the bladder are not necessarily fatal, as proved by nearly all the earlier applications of the apparatus major, in which branched dilators were used with the express object of tearing the neck of the bladder, under the impression that the parts so torn would heal better than if they had been incised. It was not until the beginning of the eighteenth century that the advantage of cutting over tearing the neck of the bladder was recognized (Schaeffer, 1704; Rosa, 1714).

Modern surgeons entertain little or no doubt that incisions through the neck of the bladder are less harmful than the bruising, lacerating violence of sudden dilatation, whether effected by dilators from without or by violence from within, in efforts to extract the stone. Hence it may be logically concluded that, for any stone an inch in diameter, or thereabouts, the neck of the bladder should be cut, and that the median operation, pure and simple, is not properly applicable under such circumstances, while either the medio-lateral, the bilateral, or the lateral operation, would be entirely appropriate.

But the median operation has a logical place. It is anatomically accurate, in that it cuts no important structure in the middle line if the bulb be spared, and that it avoids the chance of much hemorrhage. The wound generally heals promptly. The neck of the bladder, if not too much overstretched, regains its tonicity almost at once, and the patient, soon after being cut, controls his urinary evacuations nearly as well as before the operation. He is, therefore, if matters progress favorably, soon up and out, giving to the method a charm and brilliancy, both in execution and result, which are not at all as striking in any other method.

But if the stone is one inch in diameter, the patient will probably do but little less promptly well, and more safely, if to the external median incision there is added a slight incision into the neck of the bladder on one or both sides.

Therefore the median operation is most suited to small stones; but it has been shown by experience that such stones are most properly dealt with by litholapaxy, unless for some other reason it is desirable to perform cystotomy. This other reason is most commonly the presence of intense chronic cystitis, and a desire to furnish the bladder with entire rest by thorough drainage for some days. Such drainage is best effected by lateral lithotomy, for the reason that it overpowers the sphincter, but the bladder may also be drained by a large tube kept in through a central perineal wound. The latter method indeed is preferred by some operators for drainage when the choice is open, and when stone does not enter into the question of cystotomy at all, as in Sir Henry

Thompson's method of vesical exploration with the finger through a central perineal opening.

The lateral operation plainly allows a larger external opening than the median, and the internal opening by a double incision may be made as large as possible without encroaching upon the body of the bladder; therefore this operation, the lateral, logically belongs to stones over an inch in diameter, and up to such a size as the operator may feel himself justified in attacking through the perineum. Very large stones, of four, five, or even seven ounces, have been removed unbroken through the perineum, and the patients have recovered; but, as Mr. Crosse, of Norwich, has shown, the larger the stone the greater is the mortality. A stone two inches in diameter may be taken through a prostate which has been incised bilaterally—for each incision counts for three-quarters of an inch, and the natural dilatability of the urethra for another inch—but when a stone larger than this is taken out, the body of the bladder must participate in the incision, or be torn into to allow the passage.

This cutting into or tearing the body of the bladder is by no means as formidable a complication as might be supposed. In making a number of experimental incisions, and extracting smooth stones of various sizes from the cadaver, I have been surprised to see how often the body of the bladder is both cut into and lacerated when the stone to be extracted is of considerable size. Cutting into the body of the bladder was rather the rule than the exception in the apparatus minor, and it was the design and object of the operator in some of the earlier manœuvres. Again, in the child the prostate is rudimentary, the incision being made cleanly through it and into the body of the bladder beyond, yet the well-known success of lateral lithotomy with children more than justifies the procedure. Although, however, a large stone may come out safely through the perineal incision—and the more safely the younger the individual—yet, especially in old people, in view of the statistical mortality, it is not prudent to cut far, nor to use any rude force in extraction, and a large stone should be broken and extracted in fragments rather than as an uninjured trophy. The great opportunity for drainage offered by lateral cystotomy in cases of severe chronic cystitis, is a strong argument in favor of this method.

When a stone is very large—over two inches in diameter—supra-pubic lithotomy is to be preferred. The well-known mortality attending the extraction of very large stones need not again be discussed, but it is just here that the high operation has obtained some of its most brilliant triumphs. Often it has occurred that the operator, going in by the perineum, finds the stone too large to extract. He then, perhaps, attempts to break it, and fails. Finally, he opens the bladder above the pubic symphysis, takes out the stone, and recovery crowns his efforts.

Tumors have several times been removed by this same double manœuvre, and it is fair to raise the question whether the success of the high operation in these cases has not been more due to the thorough drainage of the bladder furnished by the free lateral incision than to any other cause; and whether, in a contemplated case of the high operation, it would not be good surgery, as a preliminary step, to perform either lateral cystotomy or the median operation with a large tube tied in for drainage, rather than to incur the danger of infiltration and inflammatory disturbances incident to the unnatural and undrained outlet furnished to the urine in the roof of the bladder. The Guyon-Périer method of drainage lately adopted in France may, perhaps, answer as well. If this method of reasoning be accurate, it follows, if any lithotomy is to be employed, that (1) for small stones, when the bladder is not inflamed, the median operation is appropriate; (2) for small stones, when the bladder is inflamed, unless the operator proposes to tie in a tube through the perineum,

the lateral operation should be chosen; (3) for stones at and over one inch in diameter, the lateral operation is suitable, up to stones of one and a half, and even occasionally two inches, the bilateral prostatic and even the bilateral external incision being made in such cases; (4) for stones at and above one and three-quarters inches in diameter, it is safer, after opening the perineum, to fragment the stone before extraction, this being more imperative in the case of elderly men, and (5) for very large stones, the supra-pubic operation is suitable.

Prostatic Incision.—There is more uncertainty about the internal incision in lithotomy than about any other feature of the section. Great varieties in incision into the prostate have been advocated, that which leads backward and outward in the direction of the greatest diameter of the lateral lobe of the gland having received most general approval. The respective merits of cutting and dilating have also been long and ardently discussed. Mathematical calculations have been entered upon with great precision to estimate the length of the prostatic incision on each side, and the consequent size of a stone which may be delivered through the opening without passing the limits of the prostate. This formal computation cannot be justified by a calm consideration of the facts. In the first place, the size of the prostate varies greatly at different periods of life. The measurements given conscientiously by equally good authorities vary for the same period of life. Thus the oblique radius in the adult has been made to vary all the way from ten to twenty-five millimetres.

Then, again, the prostate is not a cylindrical body, but terminates in a thick, rather abrupt, posterior border, while anteriorly it comes to a thin, blunted point. Now the stone must come out through a cylindrical channel, and the consequence is that, in the case of any stone of large size, the fibrous sheath of the prostate is necessarily cut through or torn through toward the apex of the gland, and very often posteriorly as well, while the body of the bladder is often involved.

Laceration of the soft parts about the neck of the bladder takes place in a radiate direction, following the line of a previous incision. The soft tissues also stretch considerably, but to a varying extent, in different subjects. Hence, the practical conclusion can be but one, that the incision through the neck of the bladder and the prostate should start in the direction of the greatest diameter of the gland; and that if the stone prove too large to be taken out through such an incision made with reasonable freedom, then a liberating incision must be made on the other side; and that if the stone will not even then come through after the application of moderate force, fragmentation should be resorted to, or even the high operation.

If it be decided to make the double prostatic incision, this can perhaps be most accurately done with the double-cutting lithotome caché. But frequently it turns out that the operator only determines to make his second cut after he finds that his first is inadequate. He does not usually reach this conclusion until some instruments have been passed, and the wound has been more or less dilated. Moreover, the natural elasticity of the tissues causes some displacement of the customary relations of the parts; and if, added to this, it is remembered that the second, liberating, lateral incision is made upon the finger as a guide, sometimes with the stone in the bite of the forceps more or less distending the already cut vesical orifice, it can be appreciated that this incision will not fall exactly where it is the intention of the operator to place it unless special care be used.

In experimenting upon the cadaver I have been surprised to find how easy it is to make the second incision in the wrong place. It is even possible, after having made the usual lateral incision and distended the vesical neck, to cut

upon the finger in the usual direction—outwards and slightly backwards upon the right side of the prostate—and to find upon dissection that the incision has commenced near the middle line, and perhaps severed the seminal ducts. Therefore, it is wiser in making the second incision to direct it more laterally than obliquely outwards and backwards, and in this way, if the parts have been distorted by previous distention, the line of the incision will fall about where it belongs. The incisions have been made designedly in this direction, obliquely outwards and backwards on one side and transversely on the other, by Senn, who has made a profound study of the dimensions of the prostate relatively to the question of lithotomy.

The only modern novelty in the direction of the internal incision for lithotomy has been proposed by Furneaux Jordan¹—an incision directly upwards; but it has nothing to recommend it.

OPERATIONS THROUGH THE PERINEUM.—The operations in the perineum which call for a separate description are the lateral and the bilateral, with their modifications, the median, medio-lateral, medio-bilateral, and the perineal lithotripsy of Dolbeau. The rectal operations are almost as obsolete as the apparatus major and apparatus minor.

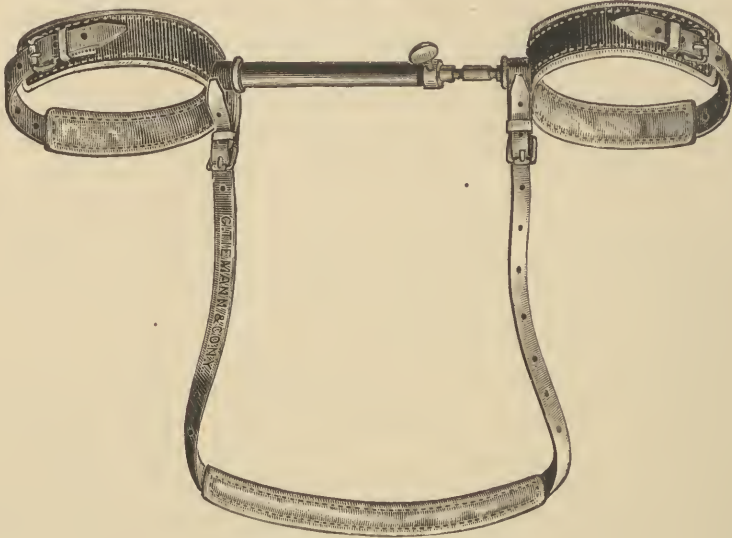
Preparations for all Perineal Operations.—These are the general preparations already advised (page 784). All previous examinations as to the condition of the kidneys, the size and position of the stone, its composition, the number of stones, and the possibility of encapsulation, must have been attended to. Obstacles, such as contracted pelvis, hernia, etc., must be noted. Hydrocele should be tapped. If stricture is present, its size and calibre must be determined, and the plan of its management decided upon. The condition of the bladder as to inflammation, and the size of the prostate, are factors in the computation. The rectum must be thoroughly cleared by an enema a few hours before the operation. Quinine, morphine, jaborandi, and diuretic mineral waters are useful here as preparatory means, just as they are in the preparations for lithotripsy. The perineum should be shaved. Five assistants are required: one for the ether, one to steady each knee, one to hold the staff—the position of honor—and a fifth to hand the instruments and do any other work that may be needed.

The table should be about thirty inches wide and very solid, furnished with a pillow and an old blanket covered with a rubber cloth. Its lower end should face a window. Beneath it are placed an old carpet or rug, and a broad basin containing sawdust, bran, or an old wet towel, so that the blood and urine dropping into it may not spatter. The operator selects such a chair or low stool as shall place the reclining body of his patient upon the table, a little lower than his chair as he sits upright. At the operator's right, within easy reach, stands a small table covered with all the instruments which can possibly be needed, the pot of vaseline for lubrication, the ligatures, and everything except the sponges. It is better to employ some fixed form of retentive apparatus than to trust to the unaided hands of assistants, be they never so skilful. The old-fashioned figure-of-eight bandage has given place to other forms of band, more solid, less liable to get out of order, and easier of adjustment. There are two varieties now in use: the bar, and the anklets and wristlets. The bar is a stiff iron cylinder with a solid extension-piece inside (Fig. 1260), by means of which it may be considerably lengthened, throwing the knees widely apart. At the ends of the bar are broad straps which hold the leg on either side just below the knee. A broad leather band completes the apparatus. This passes over the front of the shoulder on either

¹ Brit. Med. Journ., Jan. 24, 1880.

side, and behind the patient's neck. By this contrivance the patient is held compactly together, and it is possible to operate with fewer assistants; but the bar is sometimes in the way, if an instrument has to be passed through the urethra during the operation, and if the patient takes ether badly, the freedom of his hands is an objection.

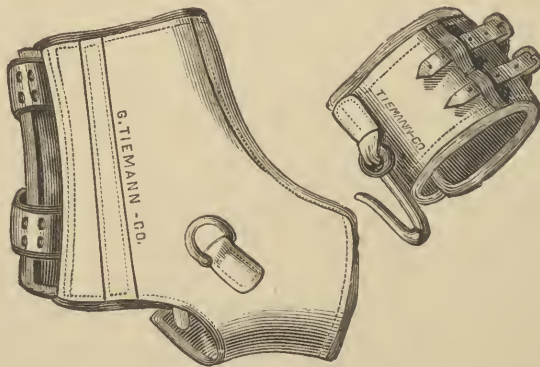
Fig. 1260.



Bar for separating limbs in lithotomy.

Of anklets and wristlets there are several varieties. Prichard's anklets and wristlets (Fig. 1261), are made of stout leather padded. The wristlet is furnished with a strong hook, and on either side of each anklet is a ring of metal. The pieces are put on separately and hooked up after anæsthesia is complete.

Fig. 1261.



Anklet and wristlet for lithotomy.

Another variety has a padded ring to slip over each foot, and, attached to the outer side of the ring, a leather strap which is to be buckled about the wrist. Another has for the anklet a flat arrangement of padded leather, with the buckles in front and a hole for the heel behind, so as to allow greater ease

of adjustment. Another, Reliquet's, has two iron bracelets, one for the wrist and one for the ankle, the latter with a retentive piece which passes under the foot. They are strapped on and hooked as usual.

All preparations being made, the patient is etherized in bed, and then carried to the table. The anklets and wristlets are next put on separately. Then the grooved staff is inserted. Tillaux relates that in one case operated upon by Civiale and Nélaton, these distinguished surgeons, having first bound their patient, had to release the bands before they could introduce the staff. The anklets are hooked to the wristlets, and the patient is drawn down to the foot of the table, the sacrum resting upon it, with the back flat, and the nates very slightly projecting beyond its end.

The assistants then steady the patient, holding the pelvis perfectly square, with the thighs equally flexed and abducted. The operator convinces himself that the end of the staff is in contact with the stone, and requests the chief assistant to verify the fact. If the stone cannot be struck by the staff in position, it is better to defer the operation. Except in cases of known encystment, the staff can always be made to touch the stone, unless the latter be quite small and lying in a *bas-fond* behind the prostate. In such a case, a finger in the rectum will raise the stone and make it strike the staff. The possibility of there being a false passage which the staff may enter, makes this precautionary verification of its contact with the stone imperative.

The chief assistant holds the handle of the staff vertically upwards from the body, sometimes slightly inclined toward the patient's head, and bulging in the perineum if the operator so desires it. His thumb presses flatly against the rough side of the handle, three fingers embrace the penis in front, and the little finger passes behind the dorsum of the member. With his left hand he draws up the scrotum, maintaining the line of the raphe exactly in a central position. With the hands so placed, the curve of the sound is to be held firmly hooked up under the symphysis. The flat side of the handle of the staff must be constantly held transversely to the long axis of the patient's body. The chief assistant must allow nothing to divert his attention; no curiosity in leaning forward to watch the cut must disturb him, and at nothing less than the command of the operator may he alter this relation of affairs until the knife has entered the groove of the staff and fairly incised the urethra.

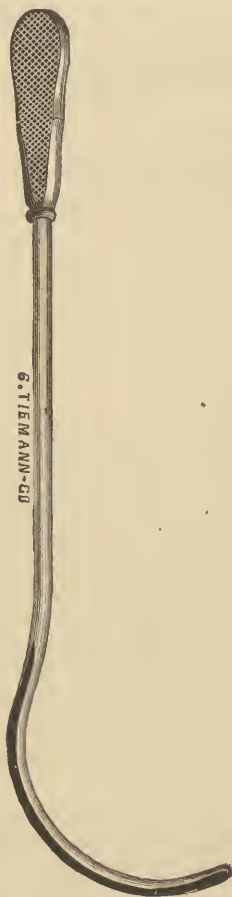
The operator now examines the rectum, and satisfies himself that it is empty, and that the curve of the sound passes the prostate. He touches the descending pubic rami, and presses centrally through the perineum upon the sound, mapping out mentally the outlet of the pelvis and the anatomical relations of the soft parts in the perineum. Having calmly taken in the situation and thought over his plan, the operator is ready, and the patient is in position for any operation upon the perineum.

I. LATERAL LITHOTOMY.—The instruments required for lateral lithotomy are a steel staff of relatively large size—at least 21 (French) for an adult—and for a child in proportion. The handle should be coarsely roughened on the side that looks toward the beak, so that the thumb of the first assistant placed against it may run no risk of slipping or allowing the instrument to turn. The old-fashioned long curve is generally preferred (Fig. 1262), the curve starting backward from the shaft and bulging slightly behind its long axis. The groove should be rather broad and deep upon the right side of the staff, winding about it as a portion of a long spiral, and should end abruptly near the tip.

A modified rectangular staff (Fig. 1263) is preferred by some operators on account of the ease with which the groove may be struck, starting as it does

at the angle of the instrument. The operation known by the name of Buchanan, of Glasgow, and favorably thought of in England, is performed with a rectangular staff inserted well into the bladder until the angle of the staff lies in the membranous urethra just in front of the apex of the prostate.

Fig. 1262.



Staff for lithotomy.

Fig. 1263.



Rectangular staff for lithotomy.

The perineum is transfixed with a sharp-pointed bistoury, the groove of the staff struck at the angle, and the knife carried directly onward into the bladder. The result is a cut like that of the lateral operation with both internal and external incisions of moderate size.

Fig. 1264.



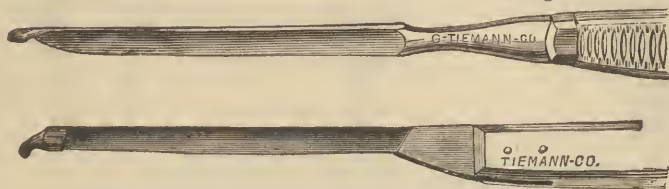
Lithotomy scalpel.

It is well to have among the lithotomy instruments an ordinary searcher, with which to explore the bladder through the wound for fragments or multiple calculi. The scalpel generally used (Fig. 1264) is moderately bellied,

seven or eight inches long, with a solid, straight back, a stout shank, and a blade about three inches long having a cutting edge of about an inch and a quarter. Some operators use the scalpel for the deep as well as for the superficial incision; but a straight, probe-pointed bistoury with a stiff back is often preferred, or the Blizard knife (Fig. 1265). The English model (Fig. 1266)

Fig. 1265.

Fig. 1266.



Blizard's probe-pointed lithotomy knife.

of the same instrument has a more pronounced probe-point. Other forms of scalpel and bistoury, and cutting gorgets, are still sometimes used. The *lithotome caché* has few advocates in this country, but in France it is still popular.

An American device, modelled after the well-known instrument of Sir James Earle,¹ is that of the late Professor N. R. Smith, of Baltimore,² and its claim has been championed by his son A. P. Smith, who has used it with brilliant success. Dr. A. P. Smith had operated 69 times at the latest report,³ with two deaths, 63 times with the instrument in question (Fig. 1267). It consists of a rectangular staff, with a knife hinged upon the shaft in such a way that it cannot fail to strike the groove. The staff is introduced, and the hinged knife is made to penetrate the urethra. Upon a groove at the back of this knife the probe-end of a broad cutting gorget, shaped like a wide scalpel, is pushed along. It cannot fail to enter the groove of the staff, and on reaching the latter the end of the gorget drops into a cup-shaped cavity in the end of a watch spring which is so arranged as to travel smoothly along the groove. The gorget, pushed steadily onwards until the end of the groove is reached, makes a cut of definite breadth in the direction of the incision of lateral lithotomy.

Among the numerous varieties of forceps used to extract stone there are two types, straight and curved. Forceps should have thin blades, slightly spoon-shaped, so as to embrace the stone and not add materially to its bulk. The extremities of the spoons should not touch when the instrument is closed, so as to avoid pinching the bladder. The inside of the spoons is rough, to prevent slipping. They are fairly broad, so that the rough stone may not project much beyond them, and their curve is rather long from before backwards, so as to throw as much of a wedge-shape as possible into the jaws when charged. The handles are usually crossed, to allow a maximum distention of the jaws with a minimum dilatation of the wound. One of the handles is always a ring for the thumb; the other is sometimes left open to allow the hand to fit upon the instrument and exercise grasping power and traction more effectively.

It is well to have at least two sizes of the straight shape. Curved forceps

¹ Practical Observations on the Operation for Stone, 2d edit., with Appendix. London, 1803.

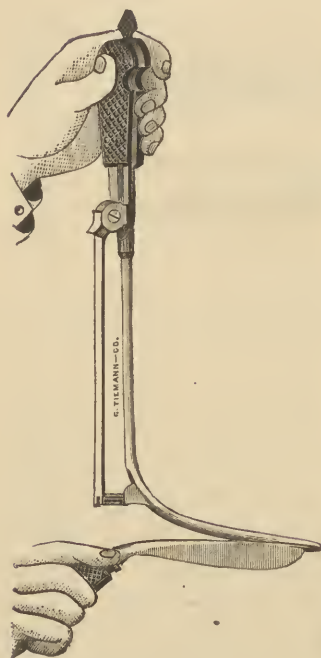
² Medical and Surgical Memoirs, by Nathan Smith, M.D., edited with Addenda by Nathan R. Smith, M.D. Baltimore, 1831. A similar instrument has also been employed by Dr. Corbet, of Glasgow. (Med. Times and Gazette, Dec. 16, 1858.)

³ Gross, System of Surgery, 6th ed., vol. ii. p. 754.

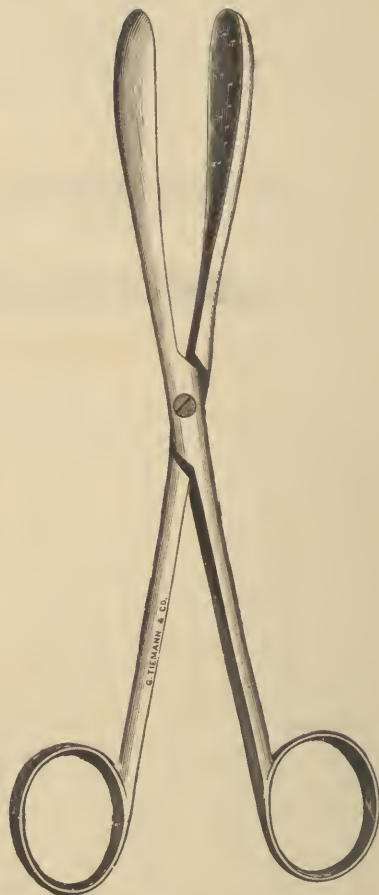
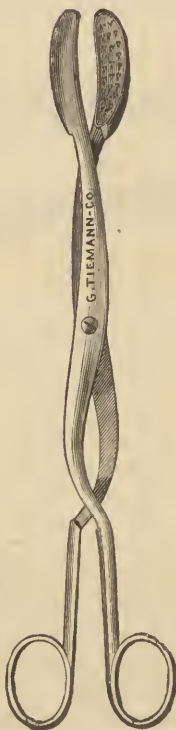
Fig. 1268.

Fig. 1269.

Fig. 1267.



N. R. Smith's staff and knife for lithotomy.



Lithotomy forceps, straight.

are used for grasping a small stone behind a large prostate, or for getting at it if it is lodged above, behind the pubis. (Fig. 1270.)

Fig. 1270.



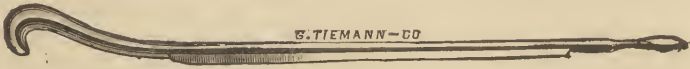
Lithotomy forceps, curved.

The crested scoop (Fig. 1271) is of great value. The scoop end removes debris. The probe-pointed extremity, fitted into the groove of the staff or following the roof of the urethra, enters the bladder without fail, and the crest serves as a certain guide to the forceps, whose closed jaws are yet sufficiently separated to receive the crest between them.

A blunt gorget having one straight and one curved margin (Fig. 1272), is recommended by Thompson, in case the perineum is so deep in a large fat

man, and the prostate so long, that the finger cannot enter the neck of the bladder. The straight side of this gorget is entered along the staff, and upon it as a guide the forceps pass into the bladder.

Fig. 1271.



Crested scoop.

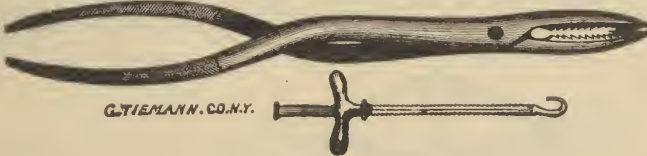
Fig. 1272.



Blunt gorget.

Forceps to crush large stones have been devised in great variety. One such instrument in common use has solid jaws, with a ridge of central teeth projecting backward in either jaw (Fig. 1273), and an adjustable hook and

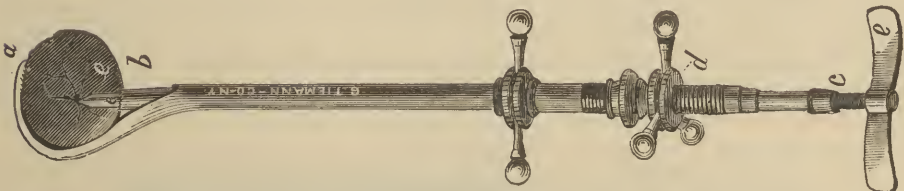
Fig. 1273.



Crusher, or brise-pierre.

screw which are attached to the handles after the stone is caught, and which allow the screw-power to be brought to bear upon the stone. This forceps resembles Dolbeau's lithoclast. A number of other ingenious lithoclasts are used, most of which will readily break a phosphatic stone as large as they can grasp, but fail with an oxalate-of-lime stone. Maisonneuve's instrument, the *éclateur* (Fig. 1274), for the fragmentation of very solid stone through a perineal

Fig. 1274.

Maisonneuve's *éclateur*.

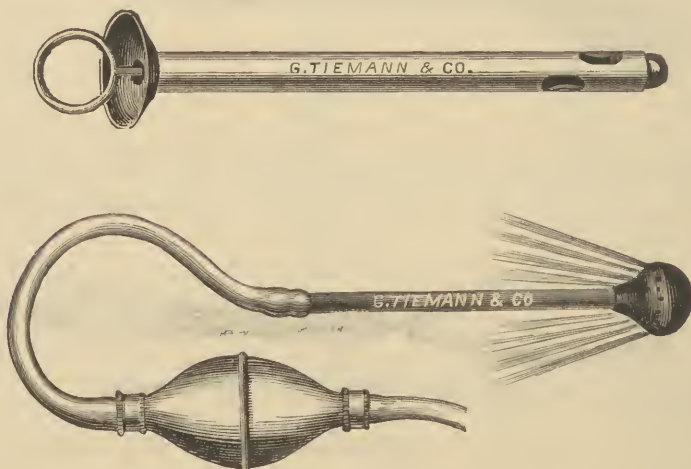
wound, is exceptionally powerful, but is clumsy and difficult of application. I have used it a number of times upon the dead body, but not upon the living. It is capable of fragmenting the hardest of urinary concretions. The curve of the female blade is insinuated carefully through the perineal wound, and by a lateral movement made to pass around and beneath the large stone. Then the male blade or perforator, *cb*, with the inner drill *ee* withdrawn, is pushed

down against the calculus and held firmly in place by turning the wheel *d*. Finally, the central drill at the end of the inner shaft *e* is by a rotation of the handle made to perforate the stone, and by further force exerted upon the wheel *d*, fragmentation is accomplished.

A straight metallic tube (Fig. 1275), half an inch in diameter, with an obturator, is useful in washing the bladder, and for the same purpose a metallic tube one-sixth inch in diameter, having a rounded head of hard rubber about half an inch in diameter with numerous perforations looking backwards (Fig. 1276); a Davidson's or other syringe with a suitable nozzle, and a piece of rubber pipe to form connections, complete the washing apparatus.

Fig. 1275.

Fig. 1276.



Tubes for washing out bladder after lithotomy.

The devices for arresting hemorrhage which have received approval over and above the common application of the ligature, and the use of heat, cold, and astringents, are seven. Of the seven, three are varieties of plugging, suitable for deep venous hemorrhage. They are the rectal tampon, the shirted canula, and the air-tampon. The four appropriate for a deep arterial hemorrhage are: (1) Horner's awl; (2) Thompson's tenaculum; (3) forcipressure forceps; (4) Gross's artery compressor.

Horner's awl (Fig. 1277), is a curved needle in a fixed handle. The thread is looped over the shoulder near the point, and the needle is passed along the

Fig. 1277.



Horner's awl.

inner side of the ascending ramus of the ischium from behind the pudic artery, starting near the tuberosity and coming out toward the surface, so that the thread may be caught, the awl withdrawn, and the solid fleshy mass

containing the artery ligated. Thompson's tenaculum (Fig. 1278) unscrews at the handle, *a*. The tenaculum including the vessel is tied in, separated

Fig. 1278.



Thompson's tenaculum with detachable handle.

from the handle, and left in the wound. The forcipressure forceps (Fig. 1279) is the best instrument for picking up any bleeding point that can be seen.

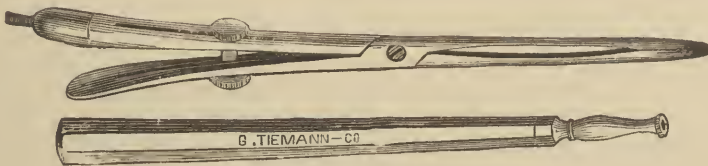
Fig. 1279.



Forcipressure forceps.

The instrument may be locked, and left in the wound twenty-four hours or longer. Gross's artery compressor (Fig. 1280) is a similar contrivance, not as easy of application.

Fig. 1280.



Gross's artery compressor.

The rectal tampon is highly spoken of by Kerr, of Canton. The centre of a square piece of cloth, well oiled, is pressed into the anus, and a narrow roller bandage packed gradually into it until enough pressure has been made upon the deep parts of the wound to arrest all hemorrhage. Sometimes a little digital pressure is made upon the tampon for a few hours, the plug being pushed up against the symphysis. An anodyne may be required to allay tenesmus while the tampon is in place. Kerr says that from six to eighteen hours is long enough to allow the tampon to remain.

The shirted canula (Fig. 1281) is a tampon consisting of a central tube of metal, around which near one end is gathered the small opening of a conical bag of coarse muslin. The bag is greased and inserted well into the wound, so that one end may lie in the vesical cavity. The conical sac is now stuffed on all sides with a thin roller bandage, until enough pressure has been brought to bear upon the sides of the wound to arrest all oozing, and then the tube is tied in. This is an excellent instrument, and even arterial hemorrhage may be arrested by its careful use. It is allowed to remain twenty-four hours or longer, according to the extent and kind of hemorrhage for the arrest of which it has been employed. The urine escapes through the tube, and

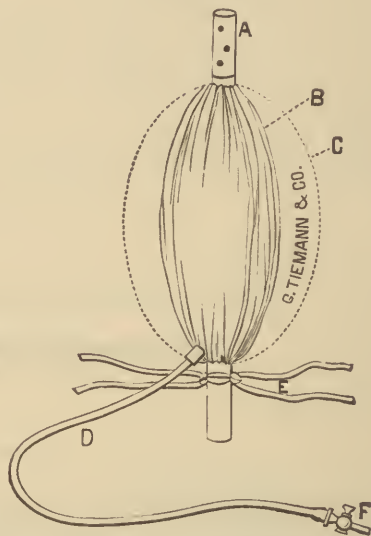
generally but little complaint is made of the pressure. It is unpacked by withdrawing the roller bandage before removal. A shirted canula may be improvised in a moment, in case of emergency, from a catheter and a square piece of muslin with a small hole in its centre.

Fig. 1281.



Shirted canula for plugging the wound after lithotomy.

Fig. 1282.



Air-tampon for hemorrhage after lithotomy.

A modern improvement upon the shirted canula is the air-tampon of Buckston Browne (Fig. 1282), the invention of which is ascribed by the French to Guyon. Both gentlemen undoubtedly devised the same instrument, each without the knowledge of the other. The figure shows Browne's tampon. It is a central tube *A*, surrounded by a thin rubber bag *B*, which in its turn is inclosed in a bag of thin swan's-down calico, to prevent bursting of the rubber bag, and to insure against its slipping out of place when once distended in the wound. The dotted lines *c*, indicate the degree of distention which is possible. *D* is the tube, with stopcock *E*, by which the rubber bag is to be distended with air or water, and *F* the strings for tying in the entire apparatus.

Guyon's tampon is a simple oval rubber bag over a hollow tube.

The English instrument-makers, Matthews Brothers,¹ claim to have devised and introduced this instrument, and add that Bryant in his "Manual for the Practice of Surgery," 1872, described their tampon five years before the appearance of Mr. Browne's article in the *Lancet*. Their tampon was intended to be distended with cold water.

This instrument is vastly the best single means of arresting hemorrhage after lithotomy which is at the surgeon's command. It is a perfected shirted canula. Its introduction, well greased, is very easy; it will arrest arterial as well as venous hemorrhage. Cold or heat may be applied to the wound without removing the tube from its place, simply by substituting hot or cold water for air. Its pressure is uniform and cannot harm the tissues. It causes less pain than any species of plugging. It insures free drainage for the urine, and allows the vesical cavity to be irrigated without removing the instrument.

¹ *Lancet*, April 19, 1884, p. 738.

It must be remembered that if the rubber is old it becomes brittle and bursts with distention. It is not well, therefore, to trust to this instrument alone. The surgeon should carry an ordinary shirted canula as well as the tampon.

The tampon is removed in not less than twenty-four hours. It has been left in several days with no disadvantage.

Anatomy of the Perineum.—It is immaterial whether we consider the perineum to be the whole of the inferior strait of the pelvis, as English authors do, or only the musculo-membranous plane which forms the anterior triangle, bounded by the rami of the ischium and pubis and by the ano-bi-ischiatic line, as is done by French writers. This triangle is really the important part in which all the work goes on in perineal lithotomy. A clear idea of the anatomy of this anterior region is essential to an intelligent operation, and a mental picture of the parts within is a guide of no mean importance to the point of the surgeon's knife.¹

The object of the operator is to pass, in the young child below, in the old subject to the left side of, the bulb, by pushing the latter out of his way from the deeper parts of the wound before his knife enters the urethra. The objective point in the urethra is the membranous portion of the canal, a little in front of the apex of the prostate. To reach it the posterior fibres of the accelerator urinae must be cut through, but the bulb and its artery should be spared, if possible. The structures which must of necessity be divided in lateral lithotomy, are the perineal integument and superficial fascia, some external hemorrhoidal vessels and nerves, the posterior fibres of the accelerator urinae muscle, some superficial perineal vessels and nerves, the transverse perineal muscle and artery, the deep perineal fascia, some anterior fibres of the levator ani, a portion of the compressor urethrae, the membranous and prostatic urethra, a part of the neck of the bladder, and a part of the prostate.

The structures to be avoided are the bulb and its artery (by starting the incision to the left of the raphe and not too far forward), the rectum (by keeping away from the middle line), the pudic artery (by not cutting too far outwards), all but a small part of the vesical neck (by maintaining the knife at a proper angle, and by not carrying the incision too far backwards).

It is well also to bear in mind that the pudic artery, ordinarily out of the way along the outer border of the perineal triangle, sometimes follows an anomalous course. Dubreuil has encountered it in the middle line, and Richet has found it nearly in the position normally occupied by the transverse perineal. The artery of the bulb, also, sometimes starts from the pudic opposite the tuber ischii, and crosses the field of the incision in its passage toward the bulb. The accessory pudic may be divided at the upper extremity of the prostate, if the incision there be too deep, and it must be remembered that the veins about the prostate, particularly in old people, are very large and sometimes bleed alarmingly.

Mode of performing the Lateral Operation.—The veteran, skilful operator sometimes plunges his knife through the skin, into and along the groove of the staff, and into the neck of the bladder, at one thrust, cutting his way obliquely out and finishing the incision in a single movement. But such a brilliant manœuvre is not desirable for general adoption. The incisions may

¹ Such a mental picture can only be obtained as the result of numerous and careful dissections. No anatomical plates can represent it in any fair way. The operator should have become familiar with the parts which he is about to cut by having frequently handled them, and he should be able to picture to himself each plane of the perineal tissues, with its muscles and vessels, as the patient lies before him on the table—at his mercy. If the surgeon cannot present this picture to his mind, he is not ready to operate.

be best executed by dividing them into three steps; the superficial incision, opening the urethra, and the deep incision.

For the *superficial incision* the operator places his left index finger upon the raphe of the perineum to steady the tissues centrally upon the groove of the staff, and enters the point of his scalpel boldly at a point about one inch and a quarter in front of the anus, and about one-third of an inch to the (patient's) left of the raphe. The incision is begun on the left of the raphe in order the more certainly in the second step of the operation to escape the bulb. The plane of the blade is directed so that the superficial incision shall lie in the perineum midway between the anus and the tuber ischii. The point of the knife is made to penetrate directly inward toward the groove of the staff, more or less deeply according to the fatness of the individual, but sufficiently to cut well through the superficial tissues at the first stroke. From thence the incision is continued downwards and outwards about two and a half inches in a line midway between the anus and the tuber ischii, growing somewhat more superficial toward its termination.

The left index finger now enters the wound, and pushes the bulb of the urethra towards the patient's right, while the pulp of the finger depresses the rectum and the nail is made to feel for the groove in the staff at a point as far back toward the membranous urethra as possible. A few light touches with the point of the knife, made always in the line of the first incision, facilitate the approach of the finger to the depths of the perineum.

The second step in the operation, *opening the urethra*, commences when the finger-nail, deep in the perineum, recognizes the inner edge of the groove in the staff. The point of the scalpel is now conducted along the nail, well backward, and made to enter the groove, when the operator and the holder of the staff at once recognize the rough feeling of contact between the two metallic surfaces. Now the back of the point of the scalpel, pressed up firmly into the groove of the staff, is run directly inwards, the blade being held more horizontally as it advances, until the point has entered the neck of the bladder. Then the handle of the knife is slightly depressed, and its blade made to cut its way outward in the line of the original incision, enlarging it more or less according to the known dimensions of the stone to be extracted, thus terminating the *deep incision*, and completing the third step in the cutting operation.

Exactly what amount of pressure to place upon the blade of the knife in executing this third step, is a matter of judgment and of individual tact and experience, which cannot be written down in words. The old operator needs no caution upon this point. The young operator should remember that his caution is liable to make him incise the neck of the bladder too modestly, and that more injury will be caused by rude efforts at extracting a large stone through too small an incision, than would follow a reasonably free incision of the bladder's neck made at one stroke downward and outward, and in a position to drain itself effectively.

Any sharp arterial spurt noticed during any of these incisions may be attended to by ligature at once, but ordinary bleeding may be disregarded. A gush of bloody urine, more or less copious according to the previous distention of the bladder, follows the withdrawal of the knife on the last incision. The left index finger is at once inserted into the bladder along the groove of the staff, and the latter is withdrawn. The finger, now within the bladder, generally touches the stone, arrests the further outflow of urine, dilates the neck of the bladder, and appreciates the depth of the incision in the same. If this be considered insufficient, the Blizard knife is inserted along the finger, and, so guided, enlarges the original deep incision, cutting evenly outward and downward, so that the bottom of the wound may be one inclined plane,

to such a depth as the operator may deem prudent. A further liberating incision into the prostate and neck of the bladder may be made upon the patient's right side, if the operator thinks it necessary.

Now the operator slides in the closed forceps upon his finger, dilating the neck of the bladder as he does so. Then taking one handle of the forceps in each hand, and gently but widely opening both blades toward the roof of the bladder, he elevates the handles, keeping the blades distended, and upon gently closing them laterally it is not improbable that he will seize the stone. If not, a second attempt is made in the same direction, or, failing again, one blade is depressed into the floor of the bladder by half rotating the instrument while the other is widely raised toward the roof. Now upon closing the blades the stone is pretty sure to be found within their grasp. If not, other efforts are made in various degrees of rotation of the instrument, perhaps aided by a finger in the rectum to raise the floor of the bladder, and finally the stone is seized. In a case of large prostate, with a *bas-fond*, the curved forceps should be used, and opened laterally upon the floor of the bladder. The same instrument may successfully seize a stone retained at the roof of the bladder, behind the pubis, in a position which would make it almost inaccessible to the straight forceps. The operator must now assure himself, if the stone is large, that it has been caught in one of its smaller diameters. This he may do by feeling the presenting portion of the stone through the wound as well as through the rectal wall.

Extraction is accomplished by traction from side to side and outwards, two-thirds lateral and one-third extractive, not directly outwards, but outwards and downwards in the axis of the inferior strait of the pelvis, easing the soft parts with a finger in the wound, and slipping them over any asperities in the presenting portion of the stone, carefully, slowly, but continuously, until the foreign body is removed. Sometimes the perineum is too deep for the finger. In such a case the crested scoop or blunt gorget may be used as a guide for the forceps. The finger or a searcher should lastly be introduced to explore for any further stone, then attention should be given to hemorrhage, and finally the bladder should be washed out with warm water.

In the child, the operation is much simpler. The urethra has no bulb to be feared before puberty, and for all practical purposes the prostate does not exist. The staff can be plainly felt through the thin tissues of the perineum. The first incision generally touches the instrument, or even enters its groove. In the latter case it should be slid along the groove for a certain distance, so as to make a clean opening into the urethra, which may be immediately encountered by the finger as it enters the wound, as otherwise there would be danger of opening the urethra in two places. The Blizard knife completes the operation, the neck of the bladder and the whole of the prostate being cut through at one incision, which should be relatively quite free, for if the neck of the bladder be not sufficiently incised in the young subject, there is danger, upon introducing the finger for purposes of dilatation, of tearing the membranous urethra across, and of pushing the neck of the bladder, undilated, before the finger upwards into the pelvis, an accident greatly to be deplored both on account of the subsequent difficulty of entering the bladder, and particularly on account of the traumatic stricture in the membranous urethra to which the transverse rent gives rise. Small, straight forceps easily extract the stone from a child, and the getting up is generally speedy.

After-treatment.—When bleeding has been arrested and the bladder thoroughly washed—a thoroughness the more requisite if the stone has been at all broken or even clipped during extraction—the patient is put to bed, preferably upon a hard hair-mattress upon which has been placed a rubber cloth, and beneath the hips a folded sheet to absorb the urine as it flows

away. This sheet must be often changed as it becomes moistened with urine, and the buttocks and perineum of the patient should be washed several times a day with warm water and alcohol, and afterwards lightly anointed with vaseline, to keep the skin in good order, particularly if the patient be fat and debilitated, and if the urine be ammoniacal. The patient may turn if he pleases, but he usually prefers to lie upon his back.

Although surgeons differ as to the advisability of tying in a catheter, the weight of authority is largely against it. It is difficult to see in what way it could be of any benefit in an ordinary case. It could not possibly prevent contact of urine with the cut surface, and it could hardly fail to prove a source of uneasiness, even if it did not set up local irritation.

The urine at first flows away freely through the cut. Then, as inflammatory swelling comes on upon the second or third day, most or all of it may pass through the urethra; but when suppuration commences and the turgescence of the tissues subsides, the urine again escapes through the perineum, at first involuntarily, then, as the neck of the bladder recovers its retentive power, at the patient's will, finally resuming its natural channel as the wound in the perineum closes.

This takes a varying period. Habitually more prompt in children (averaging perhaps ten days), and in persons in good health, it becomes longer with advancing age and in cases of debility. Three weeks is a fair time to count as a very moderate interval for repair to perfect itself in an ordinary case. Six weeks often pass before the wound is healed, and the time may extend itself to months in unfavorable cases.

It is more surgical in principle to allow the wound to heal by granulation, and to favor drainage, thus opposing any tendency toward infiltration, than to make any attempt to secure quick union. Yet primary union has been not only sought for but obtained.

Professor Dudley,¹ of Kentucky, recorded primary union after perineal lithotomy 8 times in 135 cases. Mr. Crichton,² of Scotland, made even a better record, claiming success 23 times in 200 operations, and Bonisson,³ of France, collected some interesting examples, and advocated the attempt to secure quick union in certain cases, particularly when the stone was small, and when the median operation had been employed.

Tolet, Boudou, and Ollivier have reported cases of quick union. It can hardly be called immediate, for although the urine escapes by the meatus from the first, yet the wound is not entirely healed for several—often as many as six—days. Crichton applied a simple wet compress to the wound and tied the legs together, using a warm sitz-bath in case of retention, and confining his attempts at quick union to patients in flourishing health and cases of small calculi. These attempts at quick union are of doubtful advantage, the few days that may be saved not making up for the increased risk of urinary infiltration.

Even with the wound open, a child sometimes will get up and play about within a day or two, delighted to be rid of his former tormenting pain. An adult also often gets up after the bladder has resumed its retentive power, but before the perineal wound has healed. In cases of feeble persons, such hasty movements may entail subsequent perineal fistula, but in healthy individuals they usually do not. A little opium may be required for the first day or two, to ease pain, if it be great, and some quinine and an alkaline diuretic

¹ Transylvania Journal of Medicine and the Associated Sciences, vol. ix. p. 288. 1836.

² British and Foreign Med.-Chir. Review, July, 1854.

³ De la réunion immédiate à la suite de l'opération de la taille. Gaz. Méd. de Paris, 1867, pp. 704 et seq.

are not out of place—although a milk diet generally answers for the latter. A chill and more or less fever before suppuration sets in are not infrequent, and a laxative upon the third day is often serviceable. After suppuration occurs, and granulations cover the wound, but little pain is experienced, and recovery is merely a matter of time.

The causes of death in fatal cases are much the same as those which have already been considered in speaking of lithotritry (p. 783), except that hemorrhage and shock naturally play a larger part here than in the non-cutting operation. Roux estimated that severe bleeding occurred in one-seventh of all cases operated on, and Bégin charged 25 per cent. of the bad results that followed lithotomy to hemorrhage.¹ Infiltration of urine is also more likely to occur than after the crushing operation, and therefore cellulitis, septicæmia, etc.

Obstacles Encountered before the Operation.—Aside from the questions of renal or other organic disease, and of the condition of the heart and lungs as bearing upon anæsthesia, three minor obstacles have been encountered by surgeons when considering the question of perineal lithotomy, viz., an impassable urethra, an obstacle to the left perineal incision, and a rickety pelvis. (1) If the urethral obstacle be an anterior stricture, internal urethrotomy will overcome it; if a tight, deep stricture, it may be divided as the first step in lithotomy, which should then be median. Furneaux Jordan, in such a case, made his diagnosis by acupuncture through the perineum, and cut his patient without a guide. If the obstacle be a prostatic lobe or tumor, perineal lithotomy may still be performed with the secondary object of removing the growth as one of its steps. (2) In some cases of ankylosed hip-joint the thigh is drawn across in such a way as to make section of the left half of the perineum impossible. I have seen this, the section being made in the median line. Gross reports that Pope, of St. Louis, cut a patient toward the right side in such a case, and he refers also to Zeiss's dilemma, who found a congenitally displaced testicle in the left side of the perineum, and so cut to the right. (3) In rickets the pubic and ischial rami may leave a slit between them so narrow as mechanically to oppose lithotomy. In such a case the narrowness has only to be appreciated to immediately suggest supra-pubic lithotomy, for the bladder would necessarily be high up. Thompson notes the case of a boy of four years, whose antero-posterior pelvic diameter was only an inch, and yet whose stone was extracted through the perineum.

Complications during Perineal Lithotomy.—Most of the complications likely to occur in perineal lithotomy are identical, whether the section has been lateral, bilateral, or median, and they may therefore conveniently be considered here.

Such complications as shock, heart failure under an anæsthetic, etc., need not be referred to. The patient who died of fright, while Desault was tracing out with his finger the proposed line of incision upon the perineum, cannot properly be classed among the victims of lithotomy.

Complications occur during the operation, after it, and as an ultimate result.

¹ Villeneuve, *Rev. de Chir.*, t. iii., Sept. 1883, p. 665.

(1) *Possible Complications during Perineal Lithotomy.*

- | | |
|---|--|
| 1. Failure to enter the bladder. | 10. Abnormal position of the stone due to— |
| 2. Incision of the body of the bladder. | <i>a.</i> presence of a bas-fond. |
| 3. Wounding the rectum. | <i>b.</i> its being entrapped by muscular contraction. |
| 4. Hemorrhage. | <i>c.</i> “ “ adherent. |
| 5. Rigidity of the neck of the bladder. | <i>d.</i> “ “ encysted. |
| 6. Great depth of the perineum. | 11. Wounding the bladder from within. |
| 7. Enlargement of a prostatic lobe. | 12. Foreign body as a nucleus. |
| 8. Tumor. | 13. Faulty seizure of the calculus. |
| 9. Failure to find stone after lithotomy. | 14. Multiple calculus. |
| | 15. Friable calculus. |
| | 16. Great size of calculus. |
| | 17. Aspiration of air by the rectum. |

(2) *Possible Complications after Perineal Lithotomy.*

- | | |
|--|----------------------------------|
| 1. Hemorrhage. | 9. Sloughing of the rectum. |
| 2. Filling up of the bladder by clot. | 10. Cellulitis and infiltration. |
| 3. Retention of urine. | 11. Phlebitis and pyæmia. |
| 4. Suppression of urine. | 12. Cystitis. |
| 5. Fragment left behind. | 13. Surgical kidney. |
| 6. Phosphatic incrustation of the wound. | 14. Peritonitis. |
| 7. Diphtheritic deposit upon the wound. | 15. Tetanus. |
| 8. Epididymitis. | |

(3) *Possible after-effects of Perineal Lithotomy.*

- | | |
|---------------------------|----------------------|
| 1. Incontinence of urine. | 3. Sterility. |
| 2. Impotence. | 4. Perineal fistula. |

(1) *Possible Complications during Perineal Lithotomy.—*

1. *Failure to enter the Bladder.*—This accident has occurred more than once, particularly in the case of children. It is due to the fact that the incision into the urethra and prostate is not ample enough to admit the exploring finger, and that the latter either pushes off the bladder from the urethra, or else, failing to enter the canal at all, wanders hopelessly in the cellular tissue of the recto-vesical space. The accident may be avoided in any case by passing a director along the groove of the staff before the latter is withdrawn from the bladder, and then using the director to guide the pulp of the finger into the bladder. The peculiar sensation imparted to the finger as it passes through the neck of the bladder, when once felt even upon the dead subject, is sufficient to allow the careful operator to recognize the parts and determine whether the neck of the bladder is entered by the finger or not.

If the accident should occur, by carefully following along the roof of the urethra, the apex of the prostate must be sought, the bladder opened, the stone extracted, and free drainage established with a large rubber catheter passed through the wound, where it is to be retained until free suppuration sets in. The accident is a serious one, but not necessarily fatal. Cellulitis and infiltration of urine are to be feared.

A false passage made by the staff can always be guarded against, if the operator feels the stone with his staff before making his first incision. In children, a false passage may be made by failing to recall the sharpness of the urethral curve; in adults, on account of a stricture or prostatic enlargement. The dreadful error of cutting upon a staff which has made a false route is only to be mentioned to be guarded against. Thompson has referred to two

cases in which it was proved by autopsy that the point of the staff had penetrated the roof of the bladder, thus leading to a fatal termination. He thinks that this perforation of the thin wall of an empty bladder may be the cause of certain rapidly fatal cases of peritonitis after lithotomy, and counsels the use of a staff with short curve.

2. *Incision of the Body of the Bladder.*—This incision is habitually made in children. It is also often made where large stones are extracted from the adult. In some of the operations of the earlier lithotomists the body of the bladder was always incised. The result of this depth of incision in the adult is not necessarily fatal, and, while the careful operator avoids the mistake, he may make it unwittingly, and yet the case progress satisfactorily.

3. *Wounding the Rectum.*—The rectum has been wounded at the hands of nearly all the best operators—Thompson confesses to four such cases—either because the staff has been improperly held, or the finger not used to depress the loose folds of the bowel during the deep incision, or because the gut has been very large (in old men) or much distended, or because the knife in the deep incision has not been sufficiently lateralized, or because in withdrawing a rough stone through a narrow external wound the rectum has been torn into.

The lower down toward the sphincter that the opening occurs, and the smaller it is, the more readily does it heal, particularly if the subject be young and healthy; but the accident is always a disagreeable one, and it may entail urethro-rectal fistula.

The treatment is at first expectant, as most cases recover during the healing of the wound. The rectum should be kept empty, and the wound should be frequently and freely irrigated. If fistula ensues and is well above the sphincter, after it has been allowed to contract during several months, it may be treated by cauterization with the electro-cautery or thermo-cautery, but only if the opening is not larger than a crow-quill. For larger openings a plastic operation should be attempted, by sliding the mucous membrane over the orifice, the margins of which have been previously made raw.

Such an operation is exceedingly difficult, because the fistula usually lies at the bottom of a sort of funnel, and stretching the sphincter makes the parts tense and deepens the funnel. If the fistula is low down, just above the sphincter, after due time it should be freely laid open through the sphincter and treated like an ordinary fistula in ano, or the edges may be freshened and brought together with silver wire.

4. *Hemorrhage.*—Moderate bleeding may be disregarded. An arterial spurt, however, should always receive attention at the time of its occurrence, unless it is made during the last incision, when the stone should be speedily extracted, and then the hemorrhage attended to by ligature or by some of the means already detailed (p. 836). The forcipressure forceps and the rubber tampon make hemorrhage much less to be dreaded than formerly. Very hot water injected into the wound is often efficient against oozing.

5. *Rigidity of the Neck of the Bladder.*—This is a complication encountered in old men, entirely apart from the size of the prostate. Thompson insists upon its importance. The neck of the bladder, even when incised, does not yield to dilatation, and it becomes necessary either to tear it in extracting the stone, or to cut it freely in one or more directions. The latter course is decidedly preferable, since, if an opening of a given size must be made, it is better to make it cleanly with the knife than rudely while extracting the stone.

6. *Deep Perineum.*—When the finger cannot reach beyond the prostate, or if the stone be small and so much dilatation of the neck of the bladder is not desired as would be effected by passing the forceps over the finger, a crested scoop or blunt gorget is generally used to conduct the forceps to the stone.

In cases of deep perineum also, where the bladder is so far away that the forceps cannot readily grasp the stone, the latter may be pushed down within reach by means of firm pressure made by the hand upon the hypogastrium.

7. *Enlarged Lobe of the Prostate.*—When the prostate is so large as to form a *bas-fond* in which the stone lies, the latter may be readily seized by the curved forceps, or the stone may be lifted out of its pouch by a finger in the rectum—the operator's finger, to avert an accident which occurred to Deschamps, who seized in his forceps the finger of the assistant who was trying to elevate the stone. When a third lobe is prominent, it may be accidentally pinched off and drawn away in the bite of the forceps, or may be deliberately removed as a step in the operation. I have done this with the effect of restoring to the patient the power of urination without a catheter, a power which he had totally lost for four years. Many operators speak well of the practice, while others condemn it. I believe the weight of authority to be in its favor.

Sometimes, in incising a large prostate, one of the central, encapsulated, muscular tumors which at times form part of the growth is cut into, liberated from its capsule, and extracted, either designedly or by accident, in the jaws of the forceps. Such an accident in most reported examples does not seem to have interfered with the happy progress of the case, but in one instance Gross¹ believed that the cavity which was left behind became a suppurating pouch, and increased the difficulty of urination.

8. *Tumor.*—When a tumor or fungus is encountered in the bladder, as a complication of stone, if it can be safely removed it should be taken away with forceps or the sharp spoon, as a final step in the operation.

9. *Failure to find Stone after Lithotomy.*—Sometimes the stone is so small that the gush of urine when the bladder is first opened washes out the concretion, which may be lost among the blood-clots, sponges, or towels. Such an accident has been most often noted in the case of small children, in whom the bladder contracts vigorously and in whom the cut is relatively free. With modern means of measuring the calculus such an accident ought seldom to occur; certainly never in the case of an adult, from whom so small a calculus could be more appropriately removed by litholapaxy. Occasionally the stone lies shrouded in a blood-clot or thick layer of mucus upon the floor of the bladder, and so escapes detection. An efficient search with the finger or forceps will, however, detect a movable foreign body and overcome the embarrassment. Finally, the stone may not be found because it does not exist. The names of Cheselden, Roux, Dupuytren, Crosse, and many others distinguished in the history of lithotomy, have been coupled with failures of this sort. Modern means of diagnosis should render this accident impossible.

10. *Abnormal Position of the Stone.*

(a) The complication caused by the stone lodging in the *bas-fond* of the bladder has been already considered under the head of enlarged prostate.

(b) *Stone entrapped by Muscular Contraction.*—If the bladder be large, and with thin, atonied walls, the stone may become entrapped in some of the loose vesical folds during the collapse which occurs as the water rushes out, and may thus elude a hasty search. Distention of the bladder with warm water, and search with blunt instruments and small, smooth forceps, will dislodge the stone without injury to the vesical wall. If the bladder as a whole contracts down forcibly upon the stone, anaesthesia should be pushed, and a curette or the scoop employed.

Sometimes the bladder is in a state of hour-glass contraction, retaining the stone at the top of the fundus; or a partial contraction may retain it firmly

¹ Trans. Path. Society of Phila., vol. iv. p. 153.

above, behind the pubis. In these instances the employment of the curved forceps, inverted, is of great value, but considerable caution should be exercised as to the amount of force employed. The finger or the scoop as a lever, and hot water injections, all deserve trial.

(c) *Adherent Stone*.—When the calculus is adherent to a flat surface, it either crumbles during removal, or may leave some particles still attached to the fungosities upon the site on which it rested. It should be extracted as in the case of faulty position due to spasmodic muscular action noted above; but after it has been removed the scoop or currette should be freely used, to scrape off from the bladder both the adherent particles and the granulations in which they lie. The after-treatment of such a case calls for vesical irrigation with a dilute nitric-acid solution, to guard against the re-precipitation of a phosphatic layer upon the abraded surface.

(d) *Encysted Stone*.—An encysted stone is either partly within the bladder and partly encysted, the neck of the cyst forming the obstacle to removal, or the orifice of the cyst is so small that to all intents and purposes the calculus is extra-vesical.

For the former set of cases, after the part projecting into the bladder has been removed, or before, in some cases, the operator endeavors with his finger-nail, or a director, a searcher, a scoop, or other elevator, to dilate or slightly tear the neck of the cyst and work out the calculus. In this manœuvre, pressure upon the hypogastrium or through the rectum may be of great assistance. If moderate manipulation fails to dislodge the stone, a curved, probe-pointed, long bistoury may be used with great caution upon the finger as a guide, to cut moderately the constricted edge of the neck of the cyst in one or more places. Such use of the knife involves risk, and it rests with the operator to decide according to the circumstances of each case whether to assume the risk, or to leave the stone in place and the operation unfinished, or to resort to supra-pubic section.

In the case of a large pouch connected with the bladder, and containing a small stone, the neck of the pouch may be dilated with the finger or small forceps, and the stone reached. When the stone is practically outside of the bladder, or in a dilated ureter, some operators prefer to leave it untouched. Thompson acted in this way in the presence of a stone in the ureter. It is plainly the surgeon's duty to cut scantily in such cases.

11. *Wounding the Bladder from within*.—Such an accident may occur through carelessness in the use of the staff or knife, or by seizing and tearing away a portion of the mucous membrane and muscular coat with the stone, in the grasp of the forceps. These mishaps are to be deplored and to be avoided by proper care, but the last-named accident, which is far from uncommon, is by no means always attended by serious consequences to the patient.

12. *Foreign Body as Nucleus*.—Generally the nucleus comes out with the entire stone; but the latter may crumble, leaving as a nucleus some object requiring especial care for its safe removal.

13. *Faulty Seizure of the Stone*.—This should be corrected by rotating the stone with the finger passed through the wound, or into the rectum, or by dropping the stone entirely and attempting again to catch it in a narrower diameter.

14. *Multiple Calculi*.—The first stone extracted is examined for facets. If they are found, it is certain that other stones are present; but in any case, whether the first calculus be faceted or not, search should be made to decide that the bladder is empty before the operation terminates. A partition may exist, on the other side of which more calculous material may be found. Collot operated upon a bladder from one side of which he extracted four and from the other eleven calculi.

15. *Friable Calculus.*—The stone may crumble in the jaws of the forceps. This calls for the careful use of the scoop, and for repeated washings with warm water, preferably through a retrograde canula, and for especial care in the final search that no fragments be left behind.

16. *Great Size of the Calculus.*—When the stone proves too large to be extracted safely, the choice lies between opening the bladder above the pubis or fragmenting the stone before extraction. If more than one diameter of the stone exceeds two inches, the prudent surgeon generally considers it too large for safe extraction unbroken through the perineum. If very hard or very large, therefore, it naturally calls for the supra-pubic operation, a manœuvre often successfully practised after a previous perineal opening. In fact, the drainage afforded by the latter is probably no inconsiderable help toward the success of the high operation in these cases. If the stone is broken up before extraction, the bladder requires free irrigation, as in the case of friable calculus.

17. *Aspiration of Air by the Rectum.*—This complication has been noted once by Agnew. His patient's sphincter ani, under partial anæsthesia, relaxed rhythmically with the relaxations of the diaphragm and contracted with its contractions. In this way the rectum became fully distended with air sucked in from the outside. With complete anæsthesia the phenomenon ceased.

(2) *Possible Complications after Perineal Lithotomy.*—

1. *Hæmorrhage.*—Secondary hæmorrhage may come on after lithotomy. I have only encountered it once, and then arrested it with a shirted canula.

2. *Hæmorrhage into the Bladder.*—The bladder may fill up with blood-clot after the operation. The accident is rare. Various counsels are given by authorities: to break up the clot and pump or wash it out, to inject a strong solution of pepsin in order to dissolve the clot, or to leave it alone, calming the patient with opiates. The latter course seems to me preferable. The presence of the clot affords a pressure which is the best guarantee against continuance of the hæmorrhage, opiates will quiet the patient, and, unless the mass is enormous and occludes the ureters, urine will trickle past the clot and presently dissolve it. When it softens and begins to come away, its exit may be hastened by the use of warm antiseptic irrigations with a soft catheter. If the pressure is so great that suppression seems imminent, there is no escape from the necessity of breaking up and evacuating the clot. The bladder may then be copiously irrigated with a very hot and strong solution of alum, to arrest further hæmorrhage and insure a softness of whatever clot may subsequently form. An alum clot is much better than a subsulphate-of-iron clot.

3. *Retention of Urine.*—Inflammatory swelling, or obstruction by clot, may cause retention of urine. In such a case the physical signs attest the fact, and the failure of the customary flow of urine through the wound confirms it. A female catheter passed through the wound relieves the bladder of its accumulated load. Usually this complication does not last long.

4. *Suppression of Urine.*—Of far graver significance is the occurrence of suppression. A chill may precede or accompany it, and rapidly fatal results may ensue, or the urine may again begin to flow with periods of freedom and periods of scantiness, life terminating finally with very high temperature, symptoms of acute uræmia, etc. The autopsy shows multiple abscess in the kidney. The suppression may be only partial, with or without chill (urinary fever). It is not caused by ordinary surgical fever. Its gravity depends on the accompanying signs. Heat, generally applied, poultices and mustard

upon the loins, hot drinks, stimulants, quinine, jaborandi, digitalis, and diuretics, are employed in the treatment.

5. *Fragment left behind.*—Such a complication may manifest itself during convalescence by a return of the old pain, straining, blood in the urine, etc. A search should be made before the wound has closed, and if anything is found the wound should be dilated, a small forceps introduced, and the fragment extracted.

6. *Phosphatic Incrustation of Wound.*—This occurs in the case of feeble subjects, especially in those who have had phosphatic stone with ammoniacal urine and considerable cystitis. A tough, fibrinous exudation forms upon the wound and adheres to it; sometimes indeed it is a thin slough of all the superficial tissues. This layer is infiltrated with triple-phosphate crystals, and its surface is roughened by their deposit. These fibrinous layers, diphtheritic in appearance, line the cut and may extend into and even invade the bladder, being shed from time to time in pieces of varying size. The natural healing of the wound is greatly retarded by this complication, which, according to my experience, is an evidence rather of weakness and lack of vitality on the part of the patient, than of the condition of his bladder, or of the urine which it contained at the time of the operation. Undoubtedly, a bruising of the neck of the bladder or of the track of the wound during the rough extraction of a large stone, would conduce to the formation of slough, and this slough would be covered with phosphates; but the deposit may occur independently of bruising violence. One of the most obstinate cases of this kind that I have ever seen was in the person of a seemingly healthy young man, with acid urine and a healthy bladder. He was cut cleanly in the perineum (cystotomy), as a possible means of relief from an intense neuralgia of the vesical neck.

7. *True diphtheria*, attended with all the general phenomena of the disease, may complicate the perineal wound, but the complication is exceptionally uncommon.

8. *Epididymitis and Orchitis.*—The testicle may become inflamed after lithotomy, shortly after the operation, or as late as the second week. This complication is most common upon the side which has been operated upon (left), and presents no features of moment. It is due to injury of the seminal duct, or to subsequent inflammation near the orifice of the latter. Usually only the epididymis is involved, and resolution follows in due course. Sometimes true orchitis sets in, and this may terminate in suppuration.

9. *Sloughing of the Rectum.*—An eschar may form, due to the bruising violence of extracting the stone, or to the lack of vitality of the tissues, and this may involve the rectal wall, and, separating after a few days, disclose the fact of rectal perforation by the escape of intestinal gas through the wound. The subsequent fistula is treated as already directed in cases of similar fistula caused primarily by the surgeon's knife.

10. *Cellulitis and Urinary Infiltration.*—As to whether pelvic cellulitis after perineal lithotomy is an effect or cause of urinary infiltration, has been a matter of grave dispute among authorities. Some, like Scarpa and Brodie, fearing infiltration, advise a very limited vesico-prostatic incision, and Reliquet is inclined to do the same. On the other hand, the most successful operators—Martineau, Cheselden, Thompson—have used a free incision, preferring the clean cut to any possible bruising of the tissues while extracting the stone. My belief is that too small an incision is much more dangerous in the case of a large stone than a free cut which will allow extraction without much bruising of the soft parts. In the child, the cellular tissue about the neck of the bladder is very loose, and the whole substance of the prostate is habitually cut through as well as a portion of the body of the bladder; yet

in these cases, even where the urine is ammoniacal, cellulitis and infiltration are the rarest exceptions.

In the aged, the cellular tissue about the base of the prostate is not only loose, but it is also full of large veins, and in this class of cases it is probably more often that cellulitis and subsequent infiltration are due to violence in traction upon the stone, which bruises the cellular tissue, breaks the veins, and excites phlebitis and cellular inflammation—than that simple contact of urine (even under a little pressure) with the cellular tissue about the neck of the bladder first occasions infiltration, and it again cellulitis. Undoubtedly both causes are often combined; the large stone, dragged through an insufficient cut, not only bruises the surrounding tissues but also mechanically tears open the cut widely into the cellular tissue, doing roughly what the knife could have done more surgically. I have demonstrated this fact several times upon the cadaver. A small cut is easily converted into a large tear by dragging through it a stone of disproportionate dimensions.

If the cut goes too far forward in the region of the bulb, and the urine does not escape freely by the wound, infiltration of the scrotum, perineum, etc., are possible.

The treatment of these conditions involves the free use of stimulants and all sustaining measures, incisions where they are possible, drainage, and antiseptic irrigation. When the infiltration is deep, a speedily fatal issue (in two or three days) may be expected.

11. *Phlebitis and Pyæmia.*—These complications occur less often than might naturally be expected, in consideration of the peculiar nature of the parts involved in the operation, the bruising to which they are exposed, and the purulent, putrid, ammoniacal flow from the bladder in which they are often bathed. The bulb may be opened, the large veins at the base of the prostate incised or torn, and the hemorrhoidal veins injured, yet, apart from the general condition already described in speaking of pelvic cellulitis, phlebitis and pyæmia are not common. Thompson, in an analysis of twenty cases of death in the adult, occurring in his own practice after lithotomy, only puts down one as due to pyæmia. Yet the complication undoubtedly does occur, starting in the veins, ushered in by a sharp chill (repeated afterwards at intervals), followed by high temperature, frequent feeble pulse, sweating, great physical depression, and, subsequently, a yellowish tint of the skin and conjunctivæ. Sometimes the veins of one of the thighs become implicated, the circulation of returning blood from the limb is interfered with, and the phenomena of phlegmasia alba dolens are produced.

All complications of this class are of most serious prognosis. Their treatment is conducted on general surgical principles, and includes the use of hot fomentations, local incisions when pus forms, drainage, and irrigation; with quinine, iron, and stimulants, internally, to sustain the vital forces.

12. *Cystitis.*—Cystitis is often relieved by the extraction of the foreign body, and by the rest and free drainage secured to the bladder by the dependent opening in the perineum. Sometimes, on the other hand, on account of violence done, the mucous membrane of the bladder or the walls of the organ inflame in a serious manner.

Shreds of mucous membrane may slough, become detached, and be expelled through the wound, interstitial abscesses may form, and pericystitis, or localized or general peritonitis, may be the outcome of the process. The indications are to wash the bladder frequently with mild, hot, antiseptic solutions, to use hot, local fomentations, to give demulcent drinks, and to carry on a general sustaining and stimulating internal treatment, suitable to low grades of septic inflammation of bad type.

13. *Pyelo-nephritis, the surgical kidney*, is one of the possible sequences of lithotomy. It is announced by a chill, followed by others at varying intervals; pain in the back, on one or both sides; high temperature, going somewhat up and down morning and evening, and interspersed with periods of more or less profuse sweating. The tongue becomes first sticky and coated, then dry and brown, or perhaps glazed, dry, red, and deprived of epithelium over its tip and central parts. The flow of urine varies greatly in many cases from day to day, being sometimes over-abundant, and then being quickly reduced in quantity almost to suppression. Nausea, lack of desire or ability to eat, and hiccough, accompany the later stages of this fatal complication, with delirium, sometimes mild and wandering, with picking at the bed-clothes, and sometimes attended by considerable excitement. The patient dies generally with urinary suppression and from uræmia, usually with a very high temperature. The use of morphine, with such sustaining and stimulating articles as the patient can be made to take, and hot local applications, constitute the treatment, and give all the comfort that can be afforded.

My belief is, that this form of kidney-disease, with inflammation of the pelvis, multiple abscesses, and colonies of bacteria in the renal substance, is necessarily fatal. Symptoms resembling those produced by these lesions may occur, and yet the patient recover; but I believe that, in such cases, true pyelo-nephritis has not been the cause of the symptoms.

This complication is not likely to occur except in cases in which the kidneys have been diseased in a chronic inflammatory way before the operation. Old men suffering from long-standing chronic vesical disease, in whom the ureter as well as the pelvis of the kidney is dilated and chronically inflamed, are, of all others, most liable to this complication. It is, according to my experience, the most common of all fatal complications after lithotomy or lithotomy in old men.

14. *Peritonitis*.—This complication may follow lithotomy directly, as a result of perforation of the bladder by the staff or the scalpel; or by a lesion of the peritoneal *cul-de-sac*, when the latter extends very low down and the deep incision reaches too far at the base of the prostate.

Urinary infiltration is the main cause of the mischief in these cases, which are nearly always fatal, although probably not always, for the free drainage may occasionally save the patient. As a secondary complication of interstitial cystitis, pelvic cellulitis, phlebitis, etc., the peritonitis forms part of the general process, aggravating and intensifying it, but not in itself materially adding to the gravity of the more important surgical complications of which it forms a part. The indication in peritonitis is the free exhibition of morphine subcutaneously.

15. *Tetanus* has been recorded as a cause of death after lithotomy.

(3) *Possible after-effects of Perineal Lithotomy*.—

1. *Incontinence of Urine*.—This sequence of lithotomy is happily rare. It is most common in young subjects, but in them may gradually disappear with lapse of time. When it occurs in an old man it is generally rebellious to all subsequent treatment. It is usually caused by violence (laceration, etc.), done to the neck of the bladder during rough efforts at extracting a large stone, where the internal incision is not sufficiently extensive.

The treatment is to try cauterization of the vesical neck (Thompson records one success by this method), and, failing in this, to resort to a urinal. Generally at night, when the patient is recumbent, the incontinence is less marked than during the day.

2 and 3. *Impotence and Sterility*.—The latter of these two complications—

both of which are happily very rare as after-effects of lithotomy—is more common than the former, for no matter what happens to the ejaculatory ducts, the power of erection usually remains if the testicles are preserved. But this is not invariable, as was shown by Civiale's¹ case of a man of 54, who became impotent after recto-vesical cystotomy, “ayant perdu la faculté d'entrer en érection.”

The older writers had this complication in view in advising the lateral and para-raphaeal operations rather than a deep median incision of the neck of the bladder, their object being to spare the seminal ducts. Injury was often done to these ducts, according to Ledran, in the old operation by the apparatus major, so that the semen was not ejaculated during sexual intercourse, but escaped afterwards, dribbling away or coming out upon urination. A properly directed deep incision in the lateral operation, or in the bilateral deep cut, falls outside the course of the seminal duct as it tunnels the prostate, and the testimony of all observers is of accord upon this point, that when harm is done to the seminal canals during lithotomy, its cause is to be found rather in the bruising and tearing violence exercised in extracting a large rough stone through insufficient deep incisions, than in any irregularity or excess of those excisions. A demonstration that sterility may be induced by obliteration of the vas deferens has been given by Goodhart,² who showed, at the Pathological Society in London, a specimen illustrating the obliteration of one vas deferens after lithotomy in a child. Malgaigne³ saw two cases of impotence following perineal lithotomy, and Aston Key⁴ one. Teevan gives also some testimony on this point,⁵ recording four cases in which after lithotomy there was no emission during sexual intercourse.

Treatment in cases of sterility following lithotomy is unavailing, unless it be in a case where a permanent fistula is left behind, and the semen escapes through it. In such a case the obvious remedy is closing the fistula.

4. *Perineal Fistula*.—This disagreeable after-effect of the perineal incision has been noted quite often. It may be caused by general debility of the patient, whose vital forces do not prove sufficient to effect the closure of his wound; or by some accident, such as incrustation of the walls of the wound, detention of a fragment of stone, or some sloughing or ulceration of the wound which has followed the operation; or by the existence of a stricture in the urethra anterior to the internal orifice of the fistula. A fistula cannot be said to exist until at least six months after the operation has been performed, for nature occasionally takes this much time to close the wound.

The indications for treatment are to relieve stricture, if it exists, and by diluents and local treatment of the bladder to purify the urine, should the latter be ammoniacal. Then the expedients may be resorted to of passing the catheter for each act of urination, or making pressure upon the fistula during each natural urinary act. Failing in these measures, the fistula should have its external orifice enlarged, and its track scraped so that the pyogenic membrane may be removed and the healing process stimulated; or the track of the fistula may be freshened into activity by passing into it at intervals a probe dipped in nitric acid or with a bit of nitrate of silver fused upon its tip. Finally, other means failing, the fistula may be cut down upon and its sides dissected out, the freshened surfaces being kept together and the catheter passed to draw away the urine. In some cases all efforts fail, and a permanent fistula results.

¹ Op. cit., p. 579. Paris, 1838.

² Trans. Path. Soc. Lond., 1876.

³ Journ. de Méd., Chir., et Pharm., t. xx. p. 548. 1855.

⁴ Guy's Hosp. Reports, 1st series, vol. ii. p. 26. 1837.

⁵ Trans. Clin. Soc. Lond., vol. vii. 1874, pp. 179, 180.

II. **BILATERAL LITHOTOMY.**—The bilateral operation of Dupuytren, suitable for the extraction of large stones by the perineum, is performed as follows: The patient is fixed in the ordinary lithotomy position, and the staff, having a median groove, is held centrally. A semi-lunar incision is made crossing the raphe, about one inch (from 22 to 24 millimetres) in front of the anus. The integument, cellular tissue, and anterior fibres of the sphincter are cut. The left index finger is now introduced into the wound and made to depress the rectum, while with short strokes of the knife the surgeon endeavors to free those muscular fibres, a part of the sphincter, which hold the bulb of the urethra attached to the anus. The bulb is now turned up and the finger seeks the membranous urethra far back in the wound. This is to be opened upon the nail, the knife being held transversely, to insure safety to the rectum.

The operator now takes the double lithotome caché (Fig. 1283), enters its

Fig. 1283.



Dupuytren's double lithotome caché.

point in the groove of the staff, holding the instrument's convexity upwards. As soon as the lithotome is in the bladder the staff is removed, the blades of the lithotome are protruded, and the instrument is withdrawn, at first horizontally, and then with the handle slightly lowered so as to spare the rectum. As soon as the prostate has been cut through the blades are returned to their sheaths, and the lithotome is withdrawn.

The operation of the late James R. Wood, of New York, is essentially a pre-rectal, bilateral operation. After the incision is made across the perineum in front of the rectum, and the urethra opened, the cutting part of the operation is terminated by placing the button of the bisector (Fig. 1284) in the central groove of the staff. This button is so arranged that the bisector cannot escape after its button has once entered the groove. It is pushed directly onwards into the bladder, cutting the prostate and the vesical neck to a moderate extent transversely. Dilatation does the rest.

The stone is extracted in the manner described when speaking of the lateral operation.

III. **MEDIAN LITHOTOMY.**—The median operation is suitable only for small stones. The staff should have a broad, deep, median groove. The external incision is generally made from without inwards, although most American surgeons prefer the manœuvre of Allarton,¹ who passes the left index finger into the rectum, and steadies the staff with the point of his finger pressed against it at the apex of the prostate. A stiff-backed, straight bistoury, with double cutting point, is then entered into the raphe half an inch in front of the anus and carried directly inwards, aiming for the groove in the staff at the point where it is steadied by the finger in the rectum. The groove is entered at this point, and the apex of the prostate slightly incised. The membranous urethra is cut through as the knife is being withdrawn, and the external wound is enlarged by the same motion, cutting upwards to an

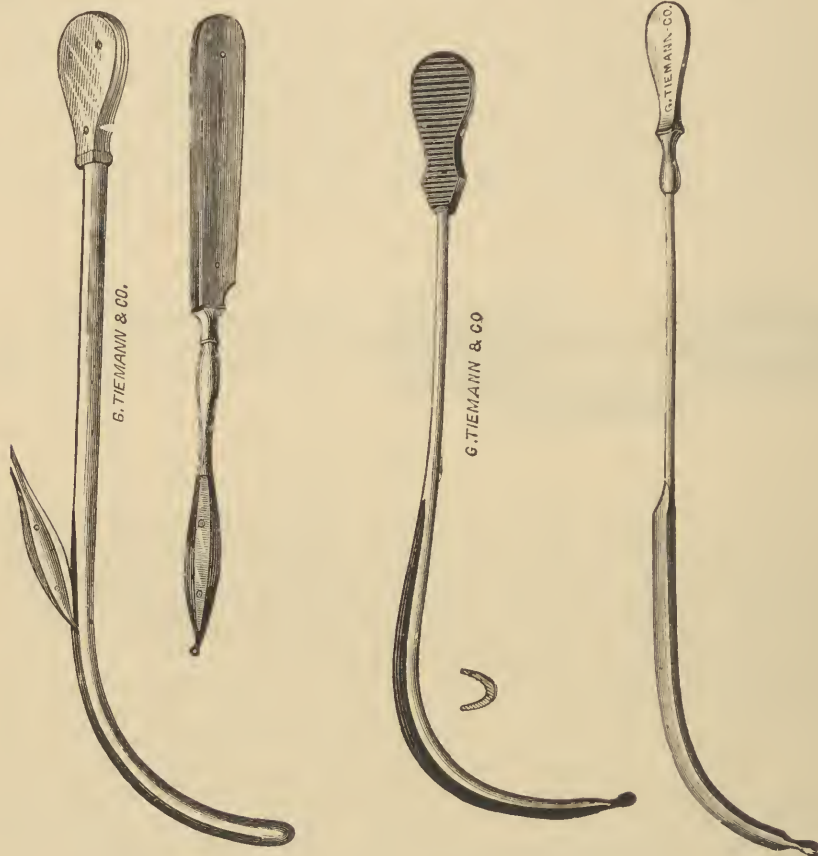
¹ A Treatise on Median Lithotomy. London, 1863.

extent deemed sufficient for the extraction of the stone. An effort is usually made, by varying the direction of the handle during this manœuvre of withdrawing the blade of the knife, to pass beneath and around the bulb, the

Fig. 1284.

Fig. 1285.

Fig. 1286.



Wood's bisector.

Staff for median lithotomy.

handle of the knife pointing nearly directly downwards while the membranous urethra is being incised, after which it is swept sharply around, looking nearly upwards as the incision in the raphe is being completed.

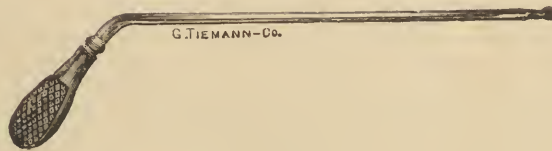
Many surgeons prefer to reach the membranous urethra in a different manner, as follows: With the left index and thumb on either side of the raphe, stretching the skin, the surgeon commences his incision with a big-bellied scalpel upon the raphe at about one and one-half inches in front of the anus, and cuts directly downwards to within one-third of an inch of the latter. The skin, cellular tissue, and superficial perineal fascia are divided until the operator comes upon the raphe uniting the lateral halves of the accelerator urinae muscle. Following this backwards, the fibres of the sphincter ani are encountered, and may be distinguished by the fact that they are not possessed of any median raphe. These are cut transversely, and the bulb, now exposed, is turned upwards out of harm's way. This method is particularly suitable to the case of old men, in whom the bulb, much enlarged, sags

downwards almost upon the rectum, and is very liable to be cut if a puncture is resorted to as in Allarton's method.

The left index is now passed into the wound behind the bulb, and made to search for the groove in the staff. The nail is there inserted, and upon this as a guide the membranous urethra is opened in the median line, and incised up to and into the apex of the prostate. The nail of the left index is maintained in its position until the right index or a director has entered the urethra, as otherwise the opening in the latter may be hard to find.

The right index finger is now gently inserted along the staff into the bladder, dilating its neck, or, in the case of children, a straight director such as Little's (Fig. 1287) is passed into the bladder, the staff is withdrawn, and

Fig. 1287.



Little's lithotomy director.

along the narrow director the finger and afterwards the forceps are carried into the organ. In this way the accident of lateral rupture of the urethra by the surgeon's finger may be avoided.

After the neck of the bladder has been properly dilated by the finger, small straight forceps are introduced, and the stone is withdrawn. Recovery is rapid if the neck of the bladder has not been bruised in attempting to extract a large stone, one not suitable for the median method.

The *medio-lateral* and *medio-bilateral* methods combine an external median opening with internal, liberating, prostatic incisions on one or both sides.

Dolbeau's *perineal lithotomy* is an operation now practically obsolete even in France, the land of its birth. It may still be used successfully when the surgeon wishes to attempt to remove a large stone by the median method. The incisions up to the apex of the prostate are made from without inwards, as in the median operation. A special dilator (Fig. 1288) is then intro-

Fig. 1288.



Dolbeau's dilator for perineal lithotomy.

duced along the staff into the neck of the bladder, and the latter is gradually enlarged up to the maximum point in the adult, which Dolbeau decided to be just short of one inch in diameter (24 millimetres). Up to this point the healthy neck of the adult bladder may be dilated without giving way. The crushing forceps (page 835) is now introduced, and, after fragmentation into a number of large pieces, the débris is removed with forceps, scoop, and irrigation. Great care is necessary not to damage the vesical neck in attempting to remove large angular fragments.

IV. SUPRA-PUBIC LITHOTOMY.—The best account of the modern high operation as it is now practised in Europe—notably in France—that I can find, is

the description by Villeneuve¹ of what he calls the Petersen-Guyon-Périer operation. I shall borrow his description. The peculiarities of this method consist essentially in the employment of antiseptic precautions, distention of the bladder and rectum to protect the peritoneum, and vesical drainage to prevent infiltration, septicæmia, and other complications due to the faulty position of the wound; for, say what one will, the position of the wound in the high operation is a faulty one, surgically speaking.

It has been held that if the exact nature, relation, and position of the parts with the course of the bloodvessels, etc., were explained to an intelligent person who had never heard of stone in the bladder, and this person were asked what would be the best way to get the stone out, he certainly, directed by common sense, would choose the shorter and more direct route, and would try to get at the stone by cutting above the pubis.

This may be true in one sense, but the answer is equally logical. If the same nature, relation, and position of parts were explained to a modern surgeon, well versed in surgical principles, and he were required to decide by induction by what route it would be most appropriate, surgically, to extract a stone from the bladder, he would certainly choose the perineal route, notwithstanding the thickness of the tissues, since natural drainage could be best accomplished by this means.

The operation of Ferdinand Petersen is the one now generally imitated, since that surgeon's able article upon the scientific principles of the method first appeared.² But none of these principles, as enunciated by Petersen, are original with him, strictly speaking, although to him belongs the credit of having grouped them into an effective whole.

Asepsis in surgery had long been acknowledged as desirable wherever it could be applied. The vesical suture dates back to Rosset, in 1581, and Périer claims for France the introduction of rectal distention by a tampon as a step in the operation, saying that Milliot announced the conception of the same method in 1875, five years before Petersen, in the Medical Congress at Lyons. Milliot³ proposed to distend the rectal tampon with air. Périer first performed the Petersen operation (somewhat modified) in France, Gosselin⁴ reporting his first two cases, one of which ended fatally. Périer⁵ has advocated a special form of drainage which Guyon⁶ has perfected. The vesical suture is not uniformly accepted in Germany, nor generally in France. E. Bouley,⁷ in his excellent monograph, collecting the cases of vesical suture from 1859 to 1881, has made a tabulated study of 23 such cases, among which failure occurred 10 times. He gives the following table:—

Catgut	used 11 times, failed 7 times.
Carbolized silk	" 8 " " 3 "
Ordinary thread	" 2 " " 0 "
Metallic suture	" 2 " " 0 "
Total	23 10

And in a general way he decides against the employment of sutures.

That the bladder may be sutured successfully is certain. Such cases have been reported by Lister, Ultzman, and others, but the tissues are very friable.

¹ Rev. de Chirurgie, t. iii., Sept. 1883, p. 665.

² Ueber Sectio Alta, Langenbeck's Archiv, S. 752. 1880.

³ Méthode opératoire par le ballonnement. Gaz. Méd. de Paris, p. 422. 1875.

⁴ Bull. de l'Acad. de Méd., 2me sér., t. x. p. 1128. 1881.

⁵ Bull. et Mém. de la Soc. de Chir., t. viii. p. 807.

⁶ Ann. des Mal. des Organes Génito-Urinaires, Déc. 1882, et Janv. 1883.

⁷ De la taille hypogastrique. Paris, 1883.

It is a different thing, in laparotomy, to turn the two peritoneal surfaces covering the bladder in upon each other and suture them effectively. This is constantly done. I know of a case in which a distinguished surgeon, having opened the abdomen in a woman for another purpose, came upon something lying in the pelvis. He was uncertain whether this something was the bladder or not, and, to decide the point, deliberately cut into the suspected tissue, and thus proved that it was the bladder. He immediately turned in the serous surfaces, and sutured them nicely; no evil result followed. T. G. Thomas,¹ of New York, in one instance, having opened the female bladder in an exploratory way for diagnostic purposes, sewed the incision into the abdominal wound with silver sutures, leaving a catheter in the bladder through the urethra; cure followed. The healthy bladder easily unites through its peritoneal coat, if this be wounded; but not so easily the soft, friable, unhealthy bladder, not covered by peritoneum at the point incised.

Trendelenburg says² that there can hardly be cited a case of vesical suture where, after a short time, urine has not flowed in part or wholly through the wound. The recent thesis of Garcin³ is instructive on this point. He deals with the 94 cases of supra-pubic operation published during the years 1879-83, and says that of 20 cases of vesical suture "there were only two cases in which union by first intention occurred." Again, out of the 94 cases, there were seven in which death occurred by urinary infiltration, and "five times this accident followed vesical suture." In one of Monod's cases, in a man⁴ of 63, suture was employed and a catheter left, *à demeure*, in the urethra. A small sinus only remained unhealed in the abdominal incision. This was afterwards injected with tincture of iodine to secure its closure, but fatal erysipelas followed. Juillard⁵ made an accidental rent five inches long in the bladder while attempting to separate adhesions in ovariectomy. He turned in the serous surfaces, not transfixing the mucous membrane with his sutures of catgut, fifteen in number, left a catheter in the urethra, and obtained union throughout the wound. Duchastelet, one of Guyon's pupils, has proposed to go so far as to open the bladder always upon its peritoneal surface for the extraction of stone, in order to get a tougher texture and a serous surface to act upon by sutures in the effort to obtain union. Villeneuve rather inclines to join in this proposition as a possible future advance for the high operation.

Upon the subject of preliminary vesical distention, as a step in the operation, something must be said. The idea is a very old one. The bladder has been allowed to become distended by urine, the penis being ligated for a variable, sometimes a very long, time (even two days) before the operation. Air has been used as the distending agent, and water, pure or containing various substances—boracic acid, carbolic acid, etc.

But the bladder has been ruptured by even moderate distention in some cases. Monod⁶ in one case fissured the bladder of a patient of 28 by injecting water—the quantity unknown—and the conclusion was reached in the discussion at the Paris Surgical Society that it was not safe to inject too much fluid, the limit being 350 grammes, a little more than eleven ounces. Petersen allows 600 grammes as the limit, 200 being the least amount. Monod's patient recovered in spite of the accident, but in a case in which Verneuil ruptured a man's bladder by injecting only 125 grammes of water,

¹ Stein, Med. Record, March 17, 1883, p. 286.

² Berliner klinische Wochenschrift, 1881.

³ Contribution clinique à l'étude de la cystotomie sus-pubienne, avec statistique comprenant les années 1879-1883. Strasbourg, 1884.

⁴ Bull. de la Soc. de Chir., 5 Décembre, 1881, p. 758.

⁵ Centralblatt für Gynäkologie, 7 Juli, 1883.

⁶ Rev. de Chirurgie, No. 4, 10 Mars, 1882, p. 296.

the result was death, showing that prudence places the minimum amount to be injected at a safety point inside of Petersen's 200 grammes.

Guyon's contribution to the Petersen-Guyon-Périer method is a special manoeuvre for rolling upwards the peritoneum out of harm's way.

The high operation may be executed with the least possible apparatus: a sound, a knife, and the fingers may accomplish it. That the operation may be safely done with rude tools, is proved by the well-known case of John Doot, the smith of Amsterdam, who cut himself above the pubis in May, 1651, with a sharp shoemaker's knife, and delivered himself successfully of a large stone. It has always seemed to me probable that this operation must have been upon a stone encysted above the pubis, perhaps trying to ulcerate its own way out, or possibly upon a stone situated in a vesical hernia in the groin—but this is conjecture only.

As to drainage of the bladder, many methods have been used. At one period in the operation it was one of the regular steps to open the urethra in its membranous portion, not purposely for drainage, but for the passage of instruments in the further continuance of the operation. Yet it is notable that in many cases of a severe character the perineum has been first opened by the lateral method in the hope of extracting the foreign body, and, when the operator has failed in this direction, the bladder has been opened above the pubis, and the offending body removed, success crowning the operation. May it not have been in these serious cases that the perineal incision, instead of being a disagreeable complication, has been in reality the means of establishing efficient surgical drainage which has saved the patient? Billroth's well-known case of myomatous tumor in the bladder was one of this kind. Watson's case, referred to by Dulles, was another, and a third was a striking case of extraction of a very large stone from a boy by Dr. Howe,¹ of New York, in which the peritoneum was opened and the intestines appeared in the supra-pubic wound. There was, however, free drainage, the perineal opening was ample, and the boy recovered.

Undoubtedly all cases cut both in the perineum and at the same time above the pubis do not recover, but it is doubtful if the perineal opening can be looked upon as a damaging complication. But there are other methods of draining the bladder more surgical than the perineal incision. The plan of leaving a soft catheter in the urethra is doubtless not a good one, because its presence in the sensitive neck of the bladder excites that organ to attempts at contraction, and the catheter may slip or be forced out, or may become occluded.

As early as 1750, Palluci perforated the *bas-fond* of the bladder, and drained it in this manner through the perineum. Deschamps, in 1796, perforated through the *bas-fond* into the rectum, and brought the tube out through the anus. McBurney, of New York, did the same thing with the "*convolvulus*" catheter a few years ago, and I have used the same method for successfully draining the bladder. But I find in my cases that the tube, be it *convolvulus* or other, is apt to slip out.

The actual cautery has been used as a means of opening the bladder, as has the *écraseur*, and the operation has been divided between two sittings; all these plans are designed to prevent infiltration, but all have been given up. The patient has been made to assume and maintain different positions after the operation, for purposes of drainage, but to no purpose. Thus even the abdominal decubitus has been insisted upon. It is said that Trendelenburg employs it.

Monod declares that the greatest danger after this operation is from infil-

¹ Reported to the New York Pathological and to the New York Surgical Societies in 1883.

tration, and that it is most often due to tearing away the cellular attachments of the bladder from the pubis. Evidently a clean incision without tearing, and thorough drainage, are the proper means to employ to prevent infiltration.

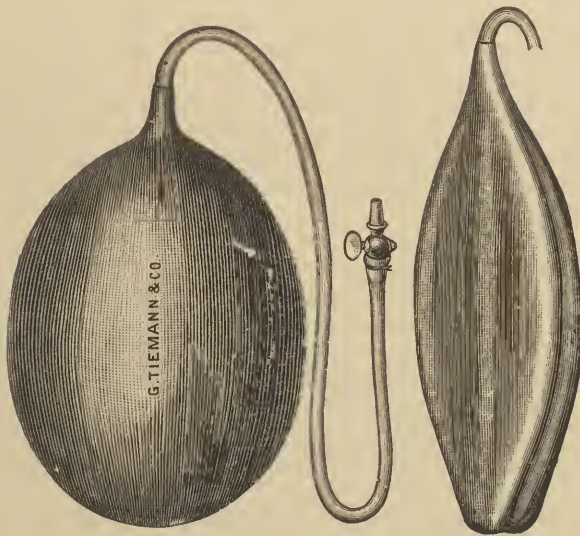
The following is a description of the Petersen-Guyon-Périer method as described by Villeneuve:—

Mode of Performing the High Operation.—All hair is to be shaved from the pubis, the parts are to be washed in an antiseptic solution (carbolic acid 1 in 20, or bichloride of mercury 1 in 1000), and all the details of antiseptic surgery are to be carried out. Anæsthesia is pushed to complete relaxation. A silver catheter with stopcock is introduced. The bladder is emptied and washed clean with a four-per-cent. solution of boracic acid. When the wash returns clean, the bladder is slowly distended with the same solution and the stopcock turned; meantime the penis has been tied over the silver catheter with a rubber tube, the tension of which is maintained by a forepressure forceps.

The amount of fluid varies with the receptivity and the degree of irritability and resistance of the bladder. If too much be thrown in, there is danger of rupturing the organ, an accident which has occurred in able hands (Monod, Cheselden, Verneuil). Two hundred grammes (between six and seven ounces) is considered a moderate amount, and six hundred grammes the limit. A piston syringe is used, and a guide to the amount to be thrown in is stated to be the resistance offered by the pressure within the bladder to the surgeon's hand as he depresses the piston—a degree of resistance to be learned by experience. It is undoubtedly wiser here to err on the side of safety. Guyon believes that an irritable condition of the bladder, not tolerating distention, contraindicates the operation.

The rubber ball (Fig. 1289) is next to be greased and inserted into the

Fig. 1289



Rectal colpeurynter, one-half natural size; distended, and collapsed for introduction.

rectum. It is an ordinary colpeurynter—Guyon insists that it should be made of stiff, thick rubber, so as to be hard and tense when distended—and through its tube from twelve to twenty ounces of warm water are to be injected. Six hundred grammes is said to be about the proper amount, but undoubt-

edly this quantity must vary in different cases. The distention of the rectum brings the bladder plainly into view above the pubis.

An incision is now made exactly in the middle line, three or four inches long, stopping at the pubic symphysis. The deep fascia is incised upon a director over the entire length of the superficial cut, and the sulcus between the recti muscles is sought. If the pyramidales are in the way, the muscular fibres are to be cut directly through in the middle line. No tearing or pulling asunder is allowable, such separation of the elements of the muscle favoring infiltration. The incision must be as clean as possible.

After getting through the muscle, a yellow layer of fat is exposed, covered by the transversalis fascia. This thin fascia is seized with forceps in the middle line, near the lower angle of the wound, a button-hole incision is made, and the left forefinger is introduced, pulp upwards. The forefinger thus placed now pushes upwards the yellow layer of fat, carrying before it the peritoneal cul-de-sac. This is Guyon's manœuvre. He says that by practising it the peritoneum is never seen. The cellulo-adipose layer, between the bladder and pubis, is not to be disturbed at all, and no effort is made to reach the neck of the bladder low down in front. Such unnecessary burrowing with the finger behind the bone invites infiltration. The finger which has pushed up the fat and the peritoneum is maintained in position in the upper angle, and serves as a guide to the point of the bistoury, which is made to puncture the bladder at this point, and to continue the incision downwards in the middle line from one and a quarter to one and three-quarters inches, according to the size of the calculus. A tenaculum, or the old-fashioned hooked gorget, or any suitable blunt hook, might be used here to hold up the upper angle of the wound in the bladder. Villeneuve and Guyon make no mention of the need of any such contrivance, saying that the finger follows the bistoury into the bladder and at once finds the stone.¹

In making the incision into the distended bladder, no attention is to be paid to a plexus of prominent veins which are seen over the front wall of the organ, and which may lie directly in the line of the proposed incision. It tears the tissues to attempt to ligate them. They are to be cleanly cut through. The hemorrhage, sometimes considerable at first, becomes arrested as the bladder collapses. If no veins are seen, Petersen's manœuvre may be adopted, cutting slowly into the muscular layers of the bladder until the mucous membrane projects through the lips of the vesical wound, then seizing the latter and incising it.

The liquid having run out, the next step is to untie the penis and remove the catheter. As this is being done the finger of the surgeon follows the bistoury into the bladder, detects the stone and places it in a position favorable for removal. The forceps follow the finger, seize the stone, and extract it slowly, and with care not to bruise the sides of the vesical incision. If the latter be too small it should be enlarged toward the neck of the bladder with a probe-pointed bistoury, as the stone is held in the forceps. All the stones having been extracted, and any débris or clot removed, the bladder is to be carefully washed with the boracic-acid solution and the rectal tampon withdrawn.

Two large parallel tubes of soft red rubber, fenestrated only at their extremity, are now to be introduced upon the finger to the bottom of the bladder near the vesical neck. These tubes must be long enough to mount over the pubes and enter a urinal placed in the bed between the patient's

¹ Since this article has been in type, I learn that Guyon now has the lips of the vesical wound held apart by loops of silk ligature inserted on either side. (*Annales de Dermatologie et de Syphiligraphie*, Nov. 1885.)

thighs. The tubes are united together by silver wire, passed through their walls, but not into their cavity, and are attached superficially to the lips of the wound by a point of superficial suture on either side.

The wound itself is closed in its upper third, the sutures being passed through the skin, superficial fascia, and borders of the recti muscles, without touching the bladder or the peritoneum. A few points of superficial suture are required, and a Lister dressing, or a bichloride or iodoform antiseptic pad is applied, the dressing being perforated for the passage of the tubes. Guyon says that he has been able to wash the bladder through one of these tubes, the flow returning through the other without wetting the dressing.

During the period of after-treatment the dressing is removed two or three times and reapplied. The tubes are taken out at the end of a week, and intermittent catheterization by the urethra is then resorted to. Drainage by this method is said to be admirable, and the cure is said to be complete by the twentieth day.

Complications.—The complications and accidents peculiar to supra-pubic lithotomy are three: Rupture of the bladder during preliminary distention, infiltration of the wound from bad drainage, and wounding the peritoneum.

The first two of these complications have already been sufficiently considered. Wounds of the peritoneum have been recorded at the hands of excellent operators (Douglas, Thornhill, Frère Côme, Souberbielle, and others). Among the 478 cases collated by Dulles it occurred as a complication 13 times, but only once with a fatal result. In Howe's case, to which I have alluded, the peritoneum was opened without any evil effect. Petersen, who, in 1878, made 14 experiments with his method upon the dead subject, never even saw the peritoneum during the operation, and in the 21 cases of the Petersen method published in France, this accident has not occurred. If the peritoneum should be wounded, and the bowel exposed, a flat sponge, wrung out of a warm antiseptic solution, should be placed over the upper angle of the wound until the operation is over, and then the peritoneal rent should be united by a very fine, continuous, catgut suture, which in its turn should be buried in the healthy tissues united above it by deep sutures from without.

Infiltration is usually fatal, but not necessarily so. It is to be treated on general surgical principles. Souberbielle only saw it once in 39 operations, and Dulles only mentions it 7 times in his tables of 478. The cleaner the cut, the less tearing of the tissues that occurs, and the better the drainage, the less is the chance of infiltration.

EXTRA-VESICAL LITHOTOMY.—A calculus in a fistulous tract outside of the bladder, or in a cystocele in the groin or labium, yields symptoms depending on its size and position. Each case becomes a special study if removal is called for, and must be met upon its merits. Cavities from which such calculi are removed should be scraped, and the vesical or urethral orifice of the tract should be closed, if possible. Extra-vesical *lithotrity* has been described as a formal surgical procedure, but it surely does not deserve the dignity of such designation.

URINARY CALCULUS IN THE FEMALE.

The same causes which lead to stone formation in the bladder of the male are equally active in the female, but the physical conditions in the latter are less favorable to the retention and growth of the foreign body in the case of primary acid calculus, because the short, large urethra offers an easy exit for the nucleus, while the absence of a prostate, the rarity of sacculation, and

the comparative infrequency of serious vesical catarrh, are sufficient to account for the relative rarity of secondary phosphatic stone in women. Cystocele, on the other hand—a condition quite analogous to sacculation—is not uncommon in the female.

Foreign bodies as a nucleus for stone play a relatively more important part in women than in men, for obvious reasons. Gynæcologists have noticed that large stones are sometimes found in the female bladder shortly after the surgical closure of a vesico-vaginal fistula. Emmet says that he has encountered many such cases, and that he sometimes has found a small portion of silver wire to be the nucleus of such a concretion. My collection contains one stone of this character, the inference being obvious that the operator, when closing the fistula, left a fragment of silver wire in the bladder. As a rule, in such cases, Emmet¹ believes that the phosphatic nucleus of the stone forms upon some denuded portion of the cut surface which has been carelessly turned inward, and left thus when the surgeon has been adjusting the edges of the vesico-vaginal wound. Campbell,² of Georgia, has taken the ground that stone may often exist within the bladder at the moment of operation for fistula, and escape the notice of the surgeon, being held up and out of the way, concealed in the folds of the bladder, by partial vesical contraction, and coming down into the vesical cavity after the latter has been formed by an obliteration of the vaginal fistula.

The relative frequency of stone in women is generally estimated at about 1 in 20 as compared with the male. In the Norwich collection (Crosse) 669 stones came from males, 35 from females, or 1 in 19. Civiale's³ statistics from the Hôtel-Dieu show that, between 1808 and 1830, out of 284 operations for stone, 17 were upon females, a ratio of 1 in 16. Again, Civiale shows that in 1104 cases in Italy, the ratio of females to males was 1 in 18, and in France among 2834 operations 1 in 22. South,⁴ in a table of operations at St. Thomas's Hospital from 1822 to 1845, gives only two as occurring in females among 144 cases, 1 in 72. Coulson⁵ has shown that out of 2834 patients, 123 were females, 1 in 23. Prout gives the same number in his estimate. Kline is quoted by Coulson as making the proportion in the Moscow City Hospital, from 1822 to 1860, much lower—1792 cases, of which 4 were in females, 1 in 448.

The symptoms of stone in the bladder in the female are similar to those observed in the male—namely, those of cystitis and vesical irritation; frequent urination, often with blood; much tenesmus; bearing-down, dragging pains in the lower belly, groins, loins, and back, sometimes streaming down the thighs; and, not infrequently, incontinence of urine. All these symptoms are aggravated by exercise, and are subject to periods of exacerbation. The symptoms sometimes simulate those of uterine disease, but physical exploration clears up the doubt.

Retention of urine in the female may be caused by impaction of stone in the urethra.

The diagnosis of stone in the female is easier than in the male. A finger in the vagina greatly facilitates the search, and a short, curved, or straight steel sound usually strikes the foreign body at once. In case of grave doubt, where a small stone is encysted or in an out-of-the-way position, it is entirely justifiable to administer ether, and, dilating the urethra, to explore the whole of the interior of the bladder with the finger. In one case,

¹ Principles and Practice of Gynæcology, p. 741. 1879.

² Trans. Am. Gynæcol. Soc., vol. i., 1875; and Emmet, op. cit.

³ Traité de l'Affectio Calculeuse, p. 594. Paris, 1838

⁴ Chelius's Surgery, vol. ii. p. 635.

⁵ Lithotrixy and Lithotomy, p. 247; and op cit., p. 370.

Thompson found a stone so thoroughly encysted as to be practically imbedded in the vesical walls, which had to be cut through in order to liberate the offending body.

Emmet¹ also describes a remarkable case. He detected a stone, found it always in the same place, and made out that it was detained in the ureter. By making backward pressure with a large sound in the bladder, the stone could always be felt by the finger, introduced either into the vagina or the rectum. Therefore, with the stone so held in place by a sound, a speculum was introduced into the vagina, and the stone was cut down upon with scissors, the wound being enlarged toward the neck of the bladder. In this way the calculus was removed without opening either the peritoneum or the vesical cavity. I have this stone in my collection now. It is about as large as the little finger, $1\frac{1}{8}$ inch long, $\frac{1}{2}$ inch in diameter, $4\frac{5}{8}$ inches in the long and $1\frac{1}{2}$ inch in the short circumference. Interrupted sutures were applied, and the patient did well.

From motives of delicacy, women often conceal the fact of being afflicted with vesical maladies, and this may perhaps explain why so many cases are on record where enormous stones have been passed spontaneously by the urethra, or have ulcerated their way through the vesico-vaginal septum. Coulson quotes Bouqué as saying that out of 204 collected cases of vesico-vaginal fistula, 6 were due to this cause. Agnew² records a personal case in which a calculus as large as a goose-egg ulcerated its way into the vagina, and in which the opening closed spontaneously without leaving a fistula behind. Gross³ refers to Collot, Beards, Baker Brown, Middleton, Botti, Klauder, Garden, and Wilks, as having recorded cases of the spontaneous discharge of stones, the calculi varying in weight from two to twelve ounces.

Tho. Molineux⁴ records the case of one Mrs. Margaret Plunkett, who expelled through the "urinary passage," without medical or surgical aid, a stone weighing $3\text{ij } 3\text{ij } 9\text{j}$ gr. vj, Troy, and having circumferences $7\frac{1}{10} \times 5\frac{3}{4}$ inches. Incontinence followed.

Another case in the Transactions is that of a "Gentlewoman of Wallingford," 63 years old, who had taken from her by her husband, without instruments and without blood, a stone having a length of $4\frac{3}{4}$ inches, and a compass of $5\frac{1}{2}$; weight 3ij , avoirdupois. She recovered with incontinence.

Garden's case⁵ is that in which four stones were passed by a woman, one of them 5×4 inches in circumference. Coulson⁶ quotes from Tulpus, that a lady of 89 passed spontaneously by the urethra a stone weighing three ounces and two drachms. Guérin⁷ records the case of a woman who passed in the same manner a stone as large as a pullet's egg, weighing nearly an ounce. This she did without any surgical aid, four days before confinement.

Incontinence of urine, generally permanent, has been found to follow the expulsion of the stone in these cases.

Yelloly⁸ records the case of a woman from whose urethra there was extracted without operation a stone weighing 3 ounces $3\frac{1}{2}$ drachms, Troy; $3\frac{1}{2}$ inches long, 2 broad, $1\frac{1}{2}$ thick; $7\frac{3}{4} \times 5\frac{1}{2}$ inches in circumference. Incontinence followed. I have found the record of another case, in a woman of 80, who passed a stone weighing 40 grammes, 5 inches in circumference. Incontinence followed at first, but after twenty days this venerable dame could hold her urine for more than an hour. She had passed 453 stones previously.

These instances go to show that this malady does not necessarily shorten life in the female. Finally, as showing how large a stone may be extracted

¹ Op. cit., p. 754.

² Op. cit., vol. ii. p. 693.

³ Urinary Organs, p. 300. 1876.

⁴ Philosophical Transactions, abridged, etc., 4th ed., 1731. Obs. 66, p. 151.

⁵ Ibid., Obs. 61, p. 150.

⁶ Op. cit., p. 370.

⁷ Journal de Méd., Chir., Pharm., etc., t. xxxi. p. 162. Paris, 1769.

⁸ Med.-Chir. Trans., vol. vi. p. 574. London, 1819.

surgically without causing incontinence, may be instanced a case recorded by W. F. Atlee.¹

The patient was an old woman of 73; the urethra was rapidly dilated, and a hard stone weighing 220 grains, $3\frac{1}{10} \times 2\frac{9}{10}$ inches in circumference, was extracted; no incontinence of urine followed.

Stone in the female bladder may prove an obstacle to parturition. Life, two lives at once, have been sacrificed from this cause.

Threlfall² records a case where the existence of stone was not suspected before labor commenced, nor diagnosticated until after death, when the calculus was removed and found to weigh 6 ounces 5 drachms 34 grains, and to be $3\frac{3}{8}$ inches long, $2\frac{1}{4}$ broad, $2\frac{1}{4}$ thick. A more fortunate case, quoted by Poland³ from Velpeau, is one in which a stone weighing $9\frac{1}{2}$ ounces was extracted from a woman in the fourth month of pregnancy with a successful result, the woman going on afterwards to a happy deliverance at term.

Hugenberger's⁴ collection of twenty-three cases of calculus occurring during pregnancy is very instructive. In four of these the stone was removed during the early months of pregnancy. In seven the patient passed the stone spontaneously, often with serious after-effect. Coulson⁵ records a personal case in which the stone had a hair-pin for a nucleus. The stone was raised above the pubis, and the labor continued favorably. Two months afterwards the stone was removed by lithotrity and the hair-pin extracted. In Monod's⁶ case, vaginal lithotomy was performed after labor had commenced, and the woman was then delivered with forceps. Erichsen⁷ cites a case in which a large stone prevented parturition and necessitated craniotomy. Craniotomy was also resorted to in Threlfall's case, already alluded to.

The obvious course to pursue when stone complicates pregnancy, is to remove the calculus at the earliest possible period. If its existence is not made out until labor sets in, the stone should, if possible, be pushed above the brim of the pelvis, out of the way of the foetal head; such a course has the sanction of high authority (Smellie, Dubois, and others). If this cannot be done, the offending body must be removed, preferably by vaginal cystotomy.

TREATMENT OF STONE IN THE FEMALE.—Cutting on the stone, the latter being seized by a finger passed above it through the vagina or (in a virgin) through the rectum, was the method first advised by Celsus, Rhazes, Albucasis, and sometimes by Paré, practised with disastrous results by Frère Jacques, and soon abandoned as an unsurgical and deadly method. Marianus Sanctus, Collot, and others advocated urethral cystotomy. After this may be mentioned the French vestibular operation devised by Lisfranc, which was very rarely practised, and which has been uniformly condemned; and then the various operations of incising the urethra, dilating the urethra, lithotrity, vesico-vaginal lithotomy, and the supra-pubic section.

At the present day but three methods retain a position of general approval, namely, (1) dilatation of the urethra for small stones, (2) litholapaxy for larger ones, unless it is desired to drain the bladder subsequently in the case of phosphatic calculi, when (3) vesico-vaginal lithotomy is the favorite.

A few words will suffice to dispose of the other methods, before taking up these three operations of choice.

Urethral Lithotomy.—The urethra has been cut below, above, laterally,

¹ Trans. Coll. Phys. Phila., N. S., vol. iv. p. 368.

² Edinburgh Med. and Surg. Journ., vol. xxxi. p. 56. 1829.

³ Art. Urinary Calculi and Lithotomy. Holmes's System of Surgery, 2d edit., vol. iv. p. 1090.

⁴ Volkmann's Sammlung klinischer Vorträge, No. 88, S. 660.

⁵ Op. cit., p. 517.

⁶ Med. Times and Gaz., vol. i. p. 356. 1858.

⁷ Referred to by Coulson (op. cit., p. 517).

bilaterally, through a part or through its entire length, and sometimes into the neck of the bladder. Generally this method is combined with dilatation of the neck of the bladder, and the wound is sutured afterwards, a soft or sometimes a Sims's hard catheter being left in the bladder for several days. The objection to this method is that it is wholly unnecessary. Any stone that can be taken out by slightly cutting the urethra, may be more easily removed by litholapaxy with less dilatation of the urethra. If the calculus is so large that the urethral incision must extend into the neck of the bladder, there is great danger of permanent incontinence, and an incision through the vesico-vaginal septum is preferable and less likely to be followed by a failure of the wound to heal, while if vesico-vaginal fistula does unexpectedly result, its subsequent closure is a comparatively simple matter.

The *supra-pubic operation* in the female is also not often called for. Its mortality, statistically, is less than in the male subject, a little more than 12 per cent. as compared with about 30 per cent. In the case of very large stones and of certain foreign bodies, perhaps in some cases of encysted stone, and possibly in very young children with small vaginæ, the high operation might be chosen with advantage. In such cases the Petersen-Guyon-Périer operation already described (page 859) would be applicable, substituting a thin rubber bag inserted into the bladder through the urethra (Milliot's method), and there inflated, in place of the vesical injection, and draining afterwards by a tube passed through the floor of the bladder and out by the vagina, instead of by two tubes through the abdominal incision, irrigation being practised through a catheter passed at stated intervals through the urethra. There remain to be considered urethral dilatation, litholapaxy, and vesico-vaginal lithotomy.

Urethral Dilatation.—Franco proposed the use of a dilator, but found that when the muscular fibres of the urethra were torn, permanent incontinence was likely to ensue. The introduction of anæsthesia has made safe dilatation more possible, and this method, as applied to the extraction of small stones less than half an inch in their smallest diameter, is entirely suitable for use at the present day. Bryant places the limit of size at which a stone may be safely extracted by dilatation, at a circumference of two inches.

Various instruments and methods have been devised for the purpose of dilating the urethral canal, some acting rapidly, some slowly. Sponge-tents, water-pressure, and all means of slow dilatation have fallen into disuse. At present it is customary to employ a two-bladed or three-bladed forceps and the fingers, commencing with the little finger. I have found the most convenient instrument to be the dilator of Dolbeau (page 855). By introducing the different sizes of this dilator, it becomes presently very possible to introduce the finger without force, and then with a narrow-bladed forceps to extract the stone. I have never dilated the female urethra to a size larger than three-fourths of an inch in diameter. This I have done a number of times for the extraction of stone and for other purposes, and I have not yet met with any case of incontinence of urine as a result either temporary or permanent. The method seems an excellent one when the stone is quite small. No after-treatment other than rest for a few days, and the administration of a urinary diluent, is called for.

Either *litholapaxy*, or *ordinary lithotripsy*, may be employed in the female with great ease and safety. The former is applicable to all cases in which the stone can be grasped and fractured by the crushing instrument. No stone is too small for it, and it might perhaps be adopted with advantage even in cases where the stone was so small that it could be safely extracted through the dilated urethra. The only cases unsuited for this operation are, where the stone is encysted, where the nucleus is some foreign body which cannot be

safely removed by crushing and washing out the fragments, where the stone is so large that it cannot be seized, or so hard that it cannot be crushed after having been caught, and, finally, where the bladder is very irritable, much inflamed or ulcerated, or contains a tumor as well as a stone, and where it is deemed wiser to leave the organ totally at rest after the operation. In such cases vaginal cystotomy is preferable to litholapaxy. Sometimes in connection with stone there is incontinence of urine, and water thrown into the bladder immediately returns through the urethra. In such a case, if the bladder does not become more passive under profound anæsthesia, the operation may still be safely performed with a small smooth lithotrite and a straight tube for washing. I have operated successfully upon female subjects at both extremes of life, in a child of four years and in an old lady past sixty.

The operative manœuvres are the same as in the male, but much simpler. A finger in the vagina may greatly aid the operator. The straight tube gives the most effective return to the washing bottle, but a curved tube may be used. The female urethra is so easily dilatable that a very large tube will pass. The after-care involves rest, and perhaps vesical irrigation, with the administration of a little anodyne for a few days.

Vaginal Lithotomy.—This operation is at present a favorite one for the extraction of stone from the female bladder, in those cases which cannot be dealt with by litholapaxy. The dependent opening can be made amply large, the bladder is drained through it effectively, the operation is safe and successful. The mortality, according to Aveling's¹ statistics collected in 1864, is about 3 per cent.—1 out of 35 cases. Vidal had 30 cases without a death, but he complained that fistula often followed. Agnew² credits 48 operations to American surgeons with two deaths. In both these cases the stone was very large. Rousset appears to have been the first to devise and perform the operation near the end of the sixteenth century. Fabricius Hildanus followed in the seventeenth. Bussière, in 1699, took out by this method a stone weighing five ounces and a half. Méry, in 1700, described the operation, and many others followed, but the fear of permanent vesico-vaginal fistula caused it to be received with caution, and to be absolutely rejected by many surgeons. According to Velpeau, permanent fistula remains in one case out of every four operated upon.

In order to overcome this tendency to persistent fistula, attempts have been made to effect immediate closure of the wound, and a number of successes have been recorded, so that this method has with many come to be looked upon as a good one. This position is, however, not accepted by American gynecologists of the present day. Emmet says that the vesical wound heals promptly after incision, if the bladder be irrigated and if incrustation of the cut edges with ammonio-magnesian deposits be prevented. He takes the ground that the wound is liable to close too promptly for the good of the bladder, that is, before the chronic inflammation has subsided, and he has recently devised a means of retaining the incision permanently open until it is the will of the surgeon to close it. This means³ is the attachment of the mucous membrane of the bladder to that of the vagina, along the entire length of the incision on both sides, by points of fine suture. In this way healing becomes impossible, and the vesico-vaginal fistula remains until the bladder has recovered, after which it is closed by the usual method.

In speaking of this operation, Emmet⁴ gives to Sims the credit of suggesting the propriety of opening the floor of the bladder in the female for the

¹ Obstetrical Transactions, vol. v. 1864.

² Op cit., vol. ii. p. 695.

³ Oral communication.

⁴ Principles and Practice of Gynecology, p. 728. 1879.

relief of chronic cystitis. The operation is performed with the patient lying in the Sims position on the left side, with the shoulders low, the hips elevated, the thighs and legs flexed. The vagina is held open by a speculum in the hands of an assistant. A sound with a short curve is introduced into the urethra and turned backwards, so that its tip sharply depresses the floor of the bladder near its neck.

A tenaculum is used to steady the parts, and this tip is cut down upon boldly, so that the wound may penetrate the vaginal and the vesical wall at the same site. Scissors are introduced into this button-hole, and an incision is made directly upwards, an inch if necessary, or a little more. Through such an incision a large stone may be removed. If it prove too large, it may be crushed with some of the powerful instruments employed for the male, and the fragments removed separately.

The patient is next placed upon her back with a bed-pan beneath her. The small nozzle of a Davidson's syringe is passed into the urethra, the vagina held open with two fingers, and copious irrigation practised until all fragments, blood-clot, etc., have been removed. If the bladder is found healthy, the wound is brought together at once with silver sutures, and the case is treated exactly like one of operation for vesico-vaginal fistula. If the bladder is not healthy, it is irrigated twice daily, and the wound is kept open by the daily introduction of a sound separating its edges, or, as Emmet now advises and practises, by attaching the vesical to the vaginal mucous membrane along the entire length of the wound on both sides. A silver suture, properly applied and twisted, will arrest any hemorrhage.

In order to keep the wound from closing too rapidly, Pallen advises that the incision should be made with the Paquelin thermo-cautery, but Emmet does not sanction this modification.

Emmet narrates a case in which, by opening the floor of the bladder, he was on one occasion enabled to detect a stone fixed in the mouth of one of the ureters, and to remove it easily by means of a narrow pair of curette forceps.

EXPLANATION OF PLATE ILLUSTRATING THE APPEARANCE OF SOME OF THE FORMS OF URINARY CALCULUS.

FIG. 1. Alternating calculus; showing on section multiple nucleus of oxalate of lime, waving lines of oxalate-of-lime formation surrounding the nuclei, then alternating layers of uric acid, urate of ammonium, oxalate of lime, and phosphates, succeeding each other. Natural size.

From the collection of Van Buren and Keyes.

FIG. 2. Uric-acid calculus, natural size, showing on section concentric lamination about the nucleus of uric acid, waving lines of oxalate of lime, and radiate structure of uric acid beyond.

From the collection of Van Buren and Keyes.

FIG. 3. Mulberry calculus, natural size. Oxalate of lime.

From the collection of Van Buren and Keyes.

FIG. 4. Kidney-stone of xanthic oxide now in Army Medical Museum, Washington. Described by Dr. G. L. Porter, Bridgeport, Conn., in the New England Medical Monthly, May, 1882.

FIG. 5. Kidney-stone of cystine, in the possession of Dr. Robt. F. Weir, of New York.

FIGS. 6, 7. Mixed phosphatic calculi, showing formation on foreign body (bit of althea root) and excentric position of nucleus. Both stones natural size.

From the collection of Van Buren and Keyes.

LITHOTRITY.

BY

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THE operation for the removal of stone in the bladder has always been considered one of the most dangerous of surgical procedures, as it is at the same time one of the most ancient. No surgical disease has given rise to more discussion, none to more controversy; and not alone in modern times, for Hippocrates dwells lengthily upon the disease and the means of its remedy; and so hazardous was any attempt at the removal of stone considered, that those who practised it were of that migratory class which deemed it inadvisable to remain long in one place, while the Father of Medicine himself considered the operation so critical, or so unworthy, or both, that he made his pupils solemnly affirm that they would never attempt it. If history is to be believed, there was a seeming necessity for this affirmation in the fact that Tryphon, the usurper, induced a lithotomist of the time to operate, with fatal result, upon Antiochus the Sixth, for a stone which did not exist.

At a later period, Celsus and the Alexandrian school taught that stone was irremediable in persons over fifteen years of age. Then, as men grew bolder, age was less considered, but the season of the year became important, and operations for stone were performed only in spring time. At that season the subjects of vesical calculus were gathered into certain localities, where the peripatetic lithotomist would visit them; and, as a certain proportion of them would die, the operator found it convenient to be soon at a safe distance from the scene of his triumphs and of his disasters, well knowing that no amount or degree of the former could render his presence safe near the scene of the latter. And thus the operation continued to fluctuate in favor till near our own day, when the operation for stone was admitted to be one of the most brilliant and useful in surgery.

During all these centuries but three principal methods were practised to open the bladder, and to reach and remove the stone: 1, by the hypogastrium; 2, by the perineum; and 3, by the rectum. And one alone, the second, while it was the oldest, continued to be that which received the most general approval. These various methods, however, are here only mentioned, as a consideration of them does not enter into the purpose of this article.

The circumstances under which vesical calculi are formed, and the symptoms which they produce, have been fully considered in the preceding article,¹ and I shall therefore proceed at once to consider the mode of exploring a bladder which is suspected to contain stone, in order to determine whether

¹ See pages 717, 752, *supra*.

or not a calculus is really present, and, if so, whether the case is one fitted for the operation of lithotrity.

INSTRUMENTS FOR EXPLORATION.—Considerable advances have of late years been made in the construction of instruments for exploration. It may be said: 1. That the instruments must be metallic—either silver, platinum, steel, or copper; I much prefer steel. It is of small moment whether they are solid or hollow—some prefer one, some the other—but it is of much moment they should not be perforated with eyelets, nor furnished with stylets. If catheters alone are available, they should be deprived of their stylets as soon as they enter the bladder, when the urine must be retained by the thumb or index finger placed over the end. 2. Of still greater moment is the shape of the instrument. It should have a short, abrupt curve. One of the shape delineated in Fig. 1290 is the best suited for

Fig. 1290.



Sound for exploring bladder.

general purposes. It differs from Van Buren's in being of uniform size throughout, and from Béniqué's in not being bellied backwards at the curve—both these instruments appearing to me objectionable. The surgeon should also be provided with similar instruments of a longer curve—like that of the ordinary catheter—and corresponding to the usual curve of the urethra. Although this is different in different persons, the curve long since adopted by Paré, afterwards by Heurteloup, and more recently still by Thompson, is that which would seem to be most generally approved in America, namely, a curve equal to one-fourth the circumference of a circle three and a third inches in diameter. Usually, the stone is most easily detected with the sharp-curved instrument, but in some situations the longer curve is serviceable. 3. The size of the sound should be much under the calibre of the urethra to be examined—not so small as to permit the urine to flow away too rapidly, yet not so large as to interfere in any degree with the easy manipulation of the instrument when in the bladder.¹

Endoscope.—In cases of suspected stone, Cruise's endoscope has been repeatedly used, but with what advantage I have yet to learn. I have, after a fair trial commenced in 1867, discontinued its use, and I can conceive of no case in which more reliable information cannot be obtained with other means of diagnosis. In my hands it has signally failed to fulfil the expectations which I had formed regarding it. Whatever value it possesses in detecting inflamed

¹ I have hitherto failed to recognize that relationship between the size of the urethra and the circumference of the flaccid penis which is described by Dr. Otis, and have not infrequently resorted to what Mr. Berkeley Hill claims as "the only exact mode of learning the size of a given urethra," the use of the urethrometer; I have, on the other hand, often had occasion to notice the frequent absence of the relationship referred to, and especially since the adoption of Bigelow's method has led me to use catheters of the largest size. It will, I think, be found that Dr. Otis's rule will not be found applicable in Canada, especially among French Canadians. This was well marked in two cases in which, a few years since, I operated in presence of Mr. Reginald Harrison, then in Montreal, when a small urethra was met with in a youth of large proportions, and a large urethra in another of very moderate proportions. Much more readily do I admit another statement of Dr. Otis, germane to this question, to wit, that we must recognize and respect a distinct individuality in each case, as regards the size of the normal urethra, irrespective of standards, or even of physical dimensions.

or ulcerated spots on the lining membrane of the urethra or bladder, it has none in searching for stone; and no practical surgeon should waste his time in using it for the latter purpose when he can more readily touch than see the calculus. As much and as little may be said of the *electric lamp*, which, however, may some day aid materially in throwing light where much is sometimes needed; and the interior of the abdomen being rendered diaphanous, an opaque body, such as a calculus, may yet be found to cast or receive a shadow. This was suggested to my mind at the meeting of the International Medical Congress in Paris, seventeen years ago, but thus far no advantage has resulted as regards the detection of stone.

EXPLORATION OF THE BLADDER.—It is advisable that this should be done, if convenient, when the bladder is more or less full. But this is a precaution of less moment than is often believed by those who labor under the erroneous impression that the bladder is always in a state of contraction upon its contents. It is true that an exploration of all parts of the organ is not as easily made when the bladder is empty; yet, as a stone is usually met with soon after entering the bladder, its presence can generally be at once made evident. If, however, a stone be not at once detected, a more thorough examination should be deferred till the bladder is partly filled. I say *partly* filled advisedly, for examination of a *full* bladder is often more painful than is that of one but partially filled. The injection of tepid water, or of any other fluid into the bladder, as a preliminary to sounding, is an objectionable procedure, and for reasons which will be stated hereafter. If the surgeon is right-handed, let him hold the sound in his right hand; if left-handed, he should use his left hand; if ambidextrous, one or the other hand; but let him not change hands during the introduction of the instrument. This cannot be done without more or less losing of ground, and without more or less disturbance of the instrument. The left hand should merely steady the penis till the point of the instrument has entered the urethra, after which there is no use for it till the prostate is reached, and not even then in children or young adults. The practice of pushing the instrument with one hand, and drawing the penis with the other, is not to be recommended. It is no doubt very desirable that one should possess a thorough knowledge of the anatomy of the urethra and of the curves which it makes in different parts of the canal, but the best knowledge is that acquired gradually by the practice of introducing the catheter into urethrae of various dimensions and of different curves. By one possessing such experience, any arbitrary rules founded upon observation in the dissecting-room are often found to be faulty. The *tour de maître* is very brilliant, but whether the instrument is introduced with handle downwards or upwards is really of small moment. What is of great moment, however, is the *slow* introduction of the instrument—even where no difficulty would be experienced in introducing it rapidly. The instrument should also be removed slowly—a matter very strongly and very wisely insisted upon by Dr. Gouley—yet not generally attended to. When the sound is within the bladder, its convex portion—the handle being elevated—may at once be felt to strike against the stone as it lies behind the prostate and near the neck of the bladder. If not, the point should be turned to right and left, then forwards and upwards; and if not in this situation the stone will not uncommonly be felt as the instrument is being drawn back towards its first position. If still not found, the sound may be turned with its point backwards in the median line, and then to the right and left.

If felt immediately after entering the bladder, and if felt in whatever direction the sound is turned, it is reasonable to conclude that the stone is a large one. If felt sometimes on one side, sometimes on the other, and if easily

displaced, its small volume may be conjectured. Its free or encysted condition may be inferred from the ease or difficulty with which, when once touched, it can be touched again. If soft and friable, the sound elicited by striking against the stone may be dull and muffled; if the "click" be a sharp one, it is usual to conjecture that the stone is hard. If, on touching it, the instrument can be sent in every other direction without feeling others, it is likely that the stone is single.

It is often found that a change in the position of the patient will facilitate the detection of stone. By some an examination in the erect posture is submitted to more readily than if lying down. It looks less formidable. It is the one I usually begin with, and, if unsatisfactory, the patient can be easily induced to assume a reclining position, or, if necessary, both in succession. On one occasion when I suspected stone, an examination in either posture was fruitless, and it was only when the patient bent forward in a *kneeling* position that the calculus could be felt. When a patient is examined in the standing posture a running conversation should be kept up to divert his attention, and also to give early intimation of dizziness, faintness, or sickness. But no patient should be allowed to pass an instrument for himself when in the erect position.¹ Sometimes, when all these methods fail with a full bladder, they may be successful with an empty or partially empty one. As the urine escapes, the instrument being just within the bladder, the calculus is drawn in against it when washed towards the urethra. When ordinary sounding fails to detect stone, it has been recommended to apply the stethoscope above the pubes while the bladder is being explored, when calculi of small size may be *heard* when they are too small to be *felt*. Another plan is to apply a sounding-board at the end of the instrument itself. In exploring for stone, however, the finger is more delicate than the ear, and the appreciation it makes of a calculus is more reliable.

Some years ago Professor Andrews, of Chicago, exhibited to the Illinois State Medical Society a stone-searcher, which utilized both the sense of hearing and that of touch. The instrument which he used consisted of a tube, hollow or solid, which was attached to an ordinary Thompson's searcher, and the free end, mounted with an ear-piece, was placed in the surgeon's ear. The suggestion is an ingenious one, but I doubt if the educated and sensitive sense of touch is much aided by this contrivance. Sand or grit which can be heard, may also be felt.

But these methods, although usually successful, are sufficiently often unsuccessful to make it our duty not to pronounce too emphatically against the existence of stone after one or two, or even several examinations, when the symptoms point in that direction. Sometimes the calculus is small and eludes detection; sometimes it lies securely imbedded in a pouch; sometimes the bladder is so dilated as to present the appearance of a second viscus; sometimes the stone lies in a kind of *cul-de-sac* of its own; sometimes, and especially in old men, the stone lies below an enlarged prostate; and sometimes it eludes detection for a time, and, when found, can be touched again at pleasure.

Desiré Bayard, aged 22, and presenting all the signs of calculus, was admitted to the Hôtel-Dieu Hospital. On introducing a sound the calculus was at once felt. Next day the patient was placed upon the operating table, and chloroform was administered preparatory to operating. The sound was again introduced, but a long and careful examination failed to establish the presence of stone. The patient was after-

¹ The members of the profession in Montreal will remember the sad result to one of the most distinguished of their body, in the prime of life, of an attempt of the kind. Before the metallic instrument had reached the bladder, he fainted and fell forwards upon it. Severe injury of the urethra was caused, with extravasation of urine, gangrene, and death.

wards brought into the operating theatre several times, and examined by myself, and also by the late Dr. Munro, the senior surgeon, whose surgical experience was perhaps not exceeded on this continent. We examined the patient when sitting, standing, and lying, and when prone and supine, with instruments of every degree of curvature, but the desired "click" was neither heard nor felt. Three weeks elapsed in this way when, examining him in bed, I caused him to kneel and bend forward upon his hands, when the characteristic click was elicited. The stone was lying below, and in front of the prostate. I turned it back with the short curved sound, and with Civiale's lithotrite seized it, and in six sittings reduced it to fragments. The stone was of uric acid, and the débris weighed more than an ounce and a half.

Sometimes an interposed membrane effectually prevents the recognition of stone. Scattered through the literature of the subject the details of numerous such cases are met with. When, however, many pouches are said to have existed in the same patient, each one hiding a stone and no part of the surface of the calculus being uncovered, I am inclined to think that possibly the instrument used may not have possessed the proper curve.

If, on the one hand, calculi may sometimes exist in the bladder and yet defy detection, there are, on the other hand, certain conditions of the urinary apparatus which give rise to the belief that calculi are present when they are not. There is scarcely a surgeon who has not felt the instrument striking against what he has erroneously considered to be a stone; and numerous have been the operations for the removal of stone where no stone existed. I shall mention these sources of error in the order of their frequency: (1) an uneven, irregular condition of the lining membrane of the bladder; (2) the folding of that membrane; (3) its roughened condition, as if sanded; (4) without any morbid condition of the bladder, the sudden jolting movement often experienced in turning the point of the sound quickly from the middle line to either right or left; (5) polypoid, fibrous, or scirrhous masses, attached or free in any part of the bladder; (6) bony or other tumors of the pubis, sacrum, or ischium; (7) the striking of the handle of the instrument against a button on the patient's or surgeon's clothing; (8) indurated feces in the rectum; and (9) in females, a misplaced uterus or ovary. These, and other sources of error, are sufficiently numerous to make it desirable not to be satisfied with once striking the calculus. A second and a third touch are advisable.

A distinguished Canadian surgeon, now dead, once fancied that he detected stone in the bladder of a young child who presented the usual signs of calculus. Lithotomy was decided upon. Of those present at the operation a select few *felt* the click; the others politely *heard* it; but when the bladder was cut into no stone was found. Fortunately for the surgeon, the child's condition was improved by the operation, and nothing disagreeable grew out of it.

Brodie, Cloquet, Houstel, Velpeau, and many others in Europe have related somewhat similar experiences.

Not only must the presence of a calculus be clearly made out, but its size, form, density, position, etc., must also be determined, and whether it is free or encysted. These are matters of interest to the lithotomist, who cuts for all calculi, hard and soft, large and small, encysted and free; but to the lithotritist, who selects his cases, they are of much greater moment. If the stone is not easily found, and if it is not easily refound; if, moreover, it moves on the slightest contact with the instrument, it is reasonable to infer that it is a small one, and that it is free. But if we meet it in all directions, and if the sound strikes it in some way in all positions as we enter the bladder, we have reason to conclude that the stone is large. Its approximate size may be determined by the sound alone, made to travel in all directions

over its surface; but its exact volume can only be made out by measurement, and the lithotrite is perhaps the most convenient instrument for the purpose.

The density of a stone may be approximately established by the sense of touch, and by the sound elicited when it is struck—the soft, friable stone usually giving out a comparatively dull sound, and the hard stone a sharp sound. But operators would fall into frequent error were they guided solely by the sense of touch or of hearing in deciding upon the density or hardness of a calculus. I have more than once elicited a very sharp, ringing sound from a soft stone; and a dull sound from a hard one. The clearness of sound not unfrequently depends upon the slight extent of contact of the calculus with the surface of the mucous membrane of the bladder; and the dullness upon the more extensive contact whereby the bladder partially envelops it and muffles the sound. Clearness or dullness often depends upon the ease and quickness with which the stone can be struck. With an instrument which completely fills the urethra, and which has its movements somewhat impeded in consequence, the sound will not be as clear as when the stone is struck quickly, sharply, lightly, and with freedom, by an instrument not so held. Moreover, the note elicited may be dull or clear according to the part of the instrument with which the stone is struck: when with the point, the sound is clearer when struck laterally than when directly; and laterally or directly, the sound is clearer than when struck by the instrument at a distance from the point. In a word, it must be borne in mind that the sound produced by striking the stone is not solely dependent upon its size, hardness, or density, but is much modified by the condition of the containing viscus and the canal which leads to it, the instrument which impinges on it, and the hand by which this is held. Indeed, the sound elicited is as different in the hands of different persons as would be the sound elicited from the same thorax, with the same hammer and pleximeter, in the hands of a Piorry and of an untrained student.

The question of number may be approximately settled by the same instrument which establishes the question of size or density. If the instrument strike a calculus on one side, and can then dip down and move about in all directions without striking another, it is reasonable to conclude that the stone is single. If, however, the instrument can be made to strike in several directions, first on one side and then on another, and can then dip down, and, as it were, elicit a separate click, first on one side and then on another, it is reasonable to conclude that the stone is not single.

But this is not always reliable, and I am now in the habit of trusting to the lithotrite alone to elucidate the question of one or more. With a calculus firmly within the jaws of the instrument, the lithotrite is made to grope for other calculi, and to elicit sounds that could not be caused by the imprisoned stone. In this way the presence of at least a second calculus can be established; but more numerous ones are not so unmistakably made out. We may conjecture their presence, however, if the instrument seems to meet with numerous bodies in all directions, displace them easily, and dip down in all directions and still displace. But it is not safe to conjecture the number by using either the sound or the lithotrite. Twelve years ago I examined an old man with the sound and made out the existence of separate calculi, but how many I could not tell, though I suspected only three or four. I urged the use of the lithotrite, but he elected the knife. I did not regret his choice, as it enabled me to remove and save twenty-five stones of almost uniform size and shape, each about the size of a hazel-nut. The number of calculi in this instance could not be approximately conjectured before the operation.

But a circumstance of greater moment than the number of calculi, as it often decides the choice of operation, is their free or encysted position within the bladder. It would seem *a priori* easy to say when a calculus is free, and,

when encysted, to determine the extent to which it is encircled. But in practice this is often found to be difficult. The sound may appear to move the calculus in all directions, but it may be the bladder which moves; or the calculus may appear immovable when it is entirely free, but within a contracted organ. The sound may be made to move around the calculus with great difficulty, yet the calculus may be free, for a large stone in a diseased and thickened bladder is not easily defined; and, on the other hand, the sound may be made to move around the calculus with much freedom though it be adherent. In 1872 I operated by lithotomy upon a boy from St. Ours. The stone was at once detected, and the sound moved around it freely, but more than half the calculus was deeply imbedded in the left ureter, from which, however, it was easily withdrawn. Sometimes the stone is more or less hidden in a pouch of the bladder from which it cannot be removed.

P. Derome, aged 72, had been for many years the subject of the usual symptoms of stone in the bladder. On examination, I found a calculus of about $1\frac{1}{2}$ inches in diameter lying at the back part of the organ, behind the prostate. I used the lithotrite, and had no difficulty in reducing a considerable portion of the stone to powder. Short sittings, and not too frequent, were then in order. Ten days afterwards I again used the lithotrite, but was able to remove but a trifling quantity. I then suggested lithotomy, but to this the patient was reluctant to submit. He died, and a post-mortem examination, at which Mr. (now Dr.) Roddick assisted, showed a calculus, its free convexity broken away by the lithotrite, and reduced apparently to about two-thirds of its original volume, deeply imbedded in the posterior wall of the bladder.

It is not always easy, when sounding for stone, to distinguish between the surface of the mucous membrane of the bladder and the surface of the pouch in which the stone is imbedded, and especially when the stone is large, and the bladder rugous or diminished in capacity. But these sacs or pouches in the bladder, containing calculi, are fortunately of rare occurrence.

When the presence of a calculus is clearly made out, and its size, form, quality, and situation determined, means for its removal are to be considered, for the number of persons reported as cured without operation—either spontaneously, or by galvanism, electricity, or injections, even when conducted in that ingenious manner styled litholysis,¹ when the stone is large, or by the use of mineral waters by the mouth, bladder, rectum, or skin, in cases of smaller calculi²—is too small to justify the postponement of operative measures. Some persons, it is true, have been cured without operation. The calculi, when small, have passed by the urethra; but generally this spontaneous passage occurs soon after they have reached the bladder, and before they have attained the size of a grain of wheat or maize. Calculi have been known to find their exit by ulceration through the perineum and the rectum; but the faint hope of such a termination should induce no sane

¹ Proposed, but, as far as I know, never practically adopted, by the late Dr. John Duncan, and published in the *Edinburgh Medical Journal*: the calculus was to be encased, while in the bladder, in a thin pouch of highly vulcanized India-rubber, introduced by a suitable contrivance; and with the interior of this pouch, containing the stone, free communication was to be had through the urethra by means of two small rubber-tubes, through one of which the operator could, at will, inject any stated quantity or kind of solvent which he might require for dealing with any particular formation, the remaining tube being for the exit of the disintegrated stone in solution.

² The curious in this matter are referred to the works of Ambroise Paré for a number of prescriptions in vogue at the time, and which received that writer's approbation, for the cure of stone without operation. They are, if nothing more, illustrations of the polypharmacy of the period, and comprise: "Syrop;" "Bouillon;" "Poudre singulière;" "Clystère;" "Autre clystère pour appaiser la douleur;" "Brevage fort commendable;" "Apozème;" "Poudre fort prepre à dissiper la matière du calcul;" "Clystère facile;" "Frictions;" "Vomissements;" "Bains;" "Décoctum pour faire un demy bain;" "Décoction à faire clystère;" "Poudre propre à comminuer le sable," etc.

person to await patiently an event so unlikely to occur, and, if occurring, far more painful and hazardous than a well-conducted surgical operation.

The methods of relief are practically but two: that by cutting and that by crushing. The first, notwithstanding the simplification of the operation, is still pregnant with danger, while advocates of the latter think it so little hazardous, and so well suited to calculi of every description, as to render the cutting operation under any circumstance uncalled for. But this is an error into which none but enthusiasts are likely to fall. To the first operation there must ever remain the dangers of shock, hemorrhage, inflammation, urinary infiltration, deep-seated abscess, gangrene, peritonitis, phlebitis, purulent infiltration, sympathetic affections of distant organs, as of the brain or pleuræ, or of the bladder, extending to the ureters, kidneys, or intestines, and the less grave risks of urinary fistula, incontinence of urine, injury to the rectum, etc. Each method of operating has its peculiar perils, though some perils are common to both.

Lithotritry has its own dangers; but whatever its dangers, whatever its disadvantages, the field for its employment is steadily widening, and lithotritry is, now-a-days, preferred to lithotomy in cases where, twenty years ago, the crushing operation would have been considered inapplicable. Even the conditions which were then considered essential to its successful performance—relating to the size and texture of the stone, the state of the viscus in which it is found, or of the channel along which the débris is to travel—are modified so as to admit a very much larger number of cases to this operation than was at one time thought to be possible. Lithotritry has its own dangers as well as its advantages, and to these and to those I shall now give attention.

DANGERS AND ADVANTAGES OF LITHOTRITY.—The term *lithotritry*, in its most extended sense, may include the seizing of a small calculus in the bladder and its extraction by the urethra; it also includes the breaking up, compression in some way, crushing, squeezing, condensation, or perforation, of large calculi, and the removal of their débris, allowing this to pass by the urethra or to be washed out of the bladder. Manœuvres so various have received various names, and the lover of Greek may find terms to his fancy or his astonishment: lithocnosis, lithodialysis, litholaby, lithomyly, lithontripsy, lithotripsy, lithoplasy, lithopriny, and lithotritry. The first eight have become almost obsolete; the last is now commonly used. In no department of surgery, perhaps, have advances been more steady and more signal than in this modern operation; modern as concerns most of its essential features. For nothing could be so unlike the present procedure as the use of the three-pronged forceps which seized and endeavored to penetrate or pierce the calculus, the *maschabarablia* of the Arabs, or the four-pronged instrument of France. But there is no satisfactory evidence that before the beginning of the present century a calculus of any size had ever been removed from the bladder without cutting—the testimony of Colonel Martine to the contrary notwithstanding. The calculi said to have been removed were from the urethra, and not from the bladder.

There is nationality sometimes even in science, and, if we put aside the claims of Gruithuisen, who first taught that sounds of large calibre could be passed with ease through the urethra, the credit of having created lithotritry unquestionably belongs to France.

To Leroy d'Étiolles is probably due the invention of the greater number of instruments designed for crushing stone, and to Civiale their more extensive employment. It is a singular fact that the introduction of the lithotrite was coëval with, and in a measure resulted from, the use of the straight catheter. Until the beginning of this century, a curve to a catheter was con-

sidered a necessity. But the use of a straight instrument led to the invention of the lithotrite, which was again, in its turn, brought to a curve as the form of greatest adaptability.

The first lithotrites were curved; but they were soon afterwards made straight, to be again curved as they are now, and are ever likely to remain. It is useless to trace the gradations from the rough, complicated, and unsafe instruments of fifty years ago, to the elegant, light, yet strong lithotrites of to-day. The circumstance that a bloodless operation for the removal of stone was found to be possible, was sufficient to stimulate the ingenuity alike of surgeon and instrument-maker in many countries in Europe; and America, in the person of Ashmead, evinced a like interest. It stimulated, at the same time, an interest in the subject of lithotomy, and reopened a consideration of the various procedures for removing the stone whole.

But the two Frenchmen already named, to whom must now be joined Amussat, Charrière, Heurteloup, Mercier, Récamier, and Tonchu, of France, more recently Sir Henry Thompson, of England, and still more recently Prof. Bigelow, of Boston, have given in their beautiful closed and fenestrated instruments the best means of quickly reducing a stone to powder and of removing it from the bladder.

Various have been the methods advocated during these fifty years, but they may be all reduced to (1) perforation; (2) perforation and divulsion, or excentric rupture; (3) concentric or surface grinding; (4) crushing.

There is nothing brilliant in any of these methods, and no opportunity is afforded for dash or boldness, or even of *sang-froid*; near assistants may *hear* an occasional crushing sound; but neither they nor the operator can *see* anything. The latter could operate equally well were he blind, for, from the beginning to the end of the operation, it is carried on in the dark. And not alone in the dark, but the peccant body, lying hidden within the bladder, is not touched save by a metallic instrument, many inches in advance of the operator's fingers. From the first discovery of the stone till its final removal from the body, there is, there can be, no contact except mediately through a metallic instrument. Of no operation in surgery can this more truly be said: "We see not what we attack, and touch not what we remove."

On several occasions I have published in the medical press some practical observations on lithotomy and lithotrity, and on the selection of the cases suitable to each operation. But every succeeding year has taken from the former and added to the latter.

Age, at one time considered an essential element in the choice, is so no longer. Even children in whom the shallowness of the perineum and the unirritating nature of the urine seemed fairly to indicate lithotomy, are now subjected to the lithotrite. Nor does old age, with its accompanying enlarged prostate, any longer forbid or render less satisfactory the operation of crushing, and since Mr. Henry Smith, of King's College Hospital, London, lithotritized with success, more than twenty years ago, a man of more than eighty-one years, persons of the most advanced age have been similarly treated.

The *state of the urethra* has much to do with the choice and also with the success of the operation; that tolerance or intolerance of the urethra—"the temper of the urethra," as Sir Benjamin Brodie styled it—which "varies as much as the temper of the mind." This tolerance or intolerance of the urethra for instruments may be easily understood by those who have noticed the great tolerance of some urethræ, and the equally great intolerance of others, for injections. There are some urethræ so tolerant of strong caustic and astringent solutions as to appear unaffected by them; while there are others so sensitive that even the most trifling addition to tepid water causes urethritis or cystitis of alarming severity. Injections of tepid water alone often

arouse inflammatory action. Before the practice of rapid lithotrity became general, when several sittings were necessary for even moderate-sized and friable calculi, this was a question of moment. But it is so no longer, and the urethra that can tolerate the grooved staff for cutting purposes, can alike bear the use of the lithotrite. The irritation sometimes set up in the urinary apparatus by the too-prolonged and too-frequent introduction of the lithotrite, is not usually irritation of the bladder, as is commonly supposed, but of the urethra; and the severe constitutional disturbance which often follows, results from the passage to and from the bladder, and not from any trouble lit up within that viscus. The bladder is not easily irritated; but the urethra is relatively sensitive and prone to disturbance. A large calculus, when broken up, as long as it remains within the bladder gives but little discomfort; but the passage of the smallest fragment causes both pain and disturbance of the circulation. It was the recognition of this greater sensibility of the urethra, probably, which led to the use of the external canula, or "chemise," as it was termed, which was placed within the urethra to protect its walls, but which is now no longer to be met with save as a curiosity in the surgical cabinet, though the sensibility of the organ which it was intended to protect has continued the same.

Nor is *stricture*,¹ whatever may be its character or situation, even if it have become cicatricial, to be regarded as an obstacle to the performance of lithotrity. If the crushing operation would be selected without stricture, it should be the more readily selected where stricture exists. Some of the most successful operations of which I have knowledge have been performed after the patients had undergone treatment for stricture. Nor are those heteroplastic growths which grow in and around, and press upon, the urinary canal, to offer insuperable obstacles to lithotrity, unless they are themselves not amenable to treatment.

The treatment necessary for the cure of stricture, whether single or multiple, and whether situated in the membranous, bulbous, or penile portion of the urethra, as a preliminary to lithotrity, familiarizes the oft-times capricious, coy, and uncertain canal to the presence of instruments, and renders the subsequent use of the lithotrite comparatively free from irritation. When dilatation alone is practised, the bougie brings the calibre of the urethra up to and beyond that required for the lithotrite, and when incision with dilatation, or internal or external urethotomy, is practised, the same result is obtained.

But other circumstances have a controlling influence on the selection or rejection of lithotrity: to wit, the size and hardness of the stone. The *size* of the calculus is less regarded than formerly, and, provided that the stone is not too hard, size alone should not prevent the performance of lithotrity. The comparatively early detection of stone, while it is yet small, has rendered the operation of lithotomy less needful. Large stones are met with less frequently than formerly. Now and then our hospitals furnish cases of stone of large size in individuals who have lived far from the aid of surgery, till forced by long suffering to find their way to the larger cities; but since the practice of lithotrity has become more general, and the detection of stone more early, calculi have been steadily decreasing in size, and promise to do so still more in the future.

The *hardness* of a stone may generally be recognized by the resistance it offers to the lithotrite, and by the manner in which the jaws of the latter grasp it. But the seemingly unmistakable evidence of hardness or of soft-

¹ By the term stricture I mean that organic stricture, that change in the wall of the urethra, either in the mucous or submucous tissue, by which is offered a greater or less impediment to the easy flow of urine. "Spasm" and "inflammation," as Mr. Reginald Harrison well observes, "may be superadded, but they do not constitute stricture in the acceptance of the term which is now generally adopted."

ness thus elicited, is liable to error: the stone may not be the same throughout:—

D—, aged 21, on the 17th of July, 1873, came to me from Syracuse, in the State of New York. He had been a sufferer from infancy. On his admission to the hospital I at once struck an enormous stone. It seemed to be soft however, and I decided to employ the lithotrite. At the first sitting a large quantity of very soft phosphatic matter was broken off and reduced to fragments, which came away during the following week, when the second sitting was begun; but the jaws of Civiale's strong-toothed instrument closed upon a calculus seemingly unlike that previously felt. The screw was applied, and as much force used as was consistent with the integrity of the lithotrite, but no impression whatever was made upon the calculus. I at once resorted to the knife, and by the lateral method safely removed a stone measuring nine and a half inches in its greatest circumference, and weighing five ounces and five drachms—the largest stone I have ever seen removed from a living body. An inspection of the specimen showed that no instrument hitherto devised could have crushed it, and that no operation, however prolonged—not even the two thousand strokes which Leroy is said to have given a calculus ineffectually—could have caused its disintegration. Its shape was a somewhat flattened ovoid. One end was partially covered with nearly a half-inch coating of soft phosphatic deposit; the other end, which rested upon and was partially encysted in the bladder, was a rough uric-acid stone; but the greater bulk of the calculus, and the part upon which the lithotrite could make no impression whatever, was of oxalate of lime. The varied structure—so adapted to mislead—and the enormous size of this stone, led me to present it the same year at a meeting of the Canada Medical Association, in St. John, New Brunswick, and I introduce here an engraving from a full-sized photograph. The patient, I may add, made a rapid recovery. In this case an examination of the urine, and even of the débris of the stone itself, would have been misleading, as the outer coating alone was soft, while the interior was of the hardest character.

Fig 1291.



Large oxalate-of-lime calculus, with external phosphatic layer.

State of Bladder and Kidneys.—What condition of the bladder contra-indicates the operation of lithotritry? I know of no condition of the bladder which alone should influence a decision in favor of lithotomy, which could not with equal reason be deemed favorable to lithotritry. Nor yet the state of the kidneys: although, as in other operations, it is desirable to have these organs in a healthy condition for removal of stone from the bladder, I know of no condition which forbids the operation, though it may have much to do with the choice of the method to be adopted.

PRELIMINARIES TO LITHOTRITY.—Surgical writers, generally, have recommended (1) that the irritable bladder should be deprived of its irritability by emollient injections before the operation; (2) that the urethra should be habituated to the passage and presence of metallic instruments before using the lithotrite; (3) that the bladder should be partially filled with tepid water or other fluid; and (4) that, when the bladder cannot retain urine for two or more hours, recourse should not be had to this procedure.

(1) In the first place, the readiest way to diminish the irritability of the bladder is to remove therefrom the calculus which has given rise to it. Emollient injections are useless, and are sometimes a source of mischief.

(2) If the urethra can be accustomed to, and become tolerant of, the sound or metallic bougie, it can as readily become accustomed to and tolerant of the lithotrite at the time of the operation. But it must be borne in mind that there are, on the part of the urethra, periods of tolerance and times of intolerance of the presence of instruments, independent altogether of the duration of their employment. At one time the urethra will bear the presence of an instrument, and at another it will not, and this without regard to the size of the instrument. It is difficult to account for this varying tolerance of instruments. It is a fact, however, known to all surgeons, and alluded to by many. Gouley says: "The instrument may have been passed at regular intervals for weeks or months without any very great amount of pain, and without giving rise to any discomfort; or it may have been followed on one or two occasions by a mild attack of fever; but finally the same careful catheterization is practised—but *on the wrong day* perhaps, when the patient's functions are temporarily disordered—and in a few hours he is suddenly and unexpectedly seized with a severe rigor from the effects of which he may never rally."

A surgeon of distinction in this city had completed very successfully the operation of lithotrixy, and the patient, relieved of his sufferings, had left the hospital and had returned to his home in the country. Some months afterwards the surgeon, being near the residence of his patient, called to see him and suggested an exploration of the bladder. A metallic sound was carefully introduced, but ere it had reached the bladder the patient was dead.

On August 20, 1881, A. B., aged 13 years, was admitted to the Hôtel-Dieu suffering from symptoms of calculus. Chloroform was used, and a metallic No. 6 sound was introduced; the bladder was explored, but no stone could be detected. No inconvenience whatever resulted from the examination, and the little fellow continued to run about the ward as if nothing unusual had occurred. Three days afterwards he was subjected to an examination of about the same duration. No difficulty was experienced in entering the bladder, no difficulty was experienced in the easy movement of the sound when within it, and no hemorrhage followed. Later in the day I was summoned to the patient's bedside, and found his condition to be alarming. He had had a rigor which had lasted a couple of hours; he had now a pale and anxious countenance, and a weak, thread-like pulse (140), and cold extremities. From this condition he did not rally, and he died in the afternoon of the following day, twenty-eight hours after the second exploration. The anæsthetic (chloroform) and instruments (No. 6 long, curved, silver sound, and Sir H. Thompson's explorer) were the same in both instances, and employed by the same persons; and the duration of the examination on both occasions (about six minutes) was about the same, and on both occasions in presence of the same class, in the same surgical theatre. The body was so quickly claimed by the relatives that no post-mortem examination was obtainable.

(3) The suggestion to fill the bladder with tepid water, or at least to introduce eight or ten ounces, is made under the impression that the movements of the instrument will thus be freer, and that the detection and seizure of the stone will be easier. But this impression arises from a misconception of the true state of the bladder. That viscus is but sparingly supplied with mus-

cular tissue, and it is not contracted upon its contents, as is the uterus. The walls of the bladder lie in easy apposition, and the lithotrite can move about as readily in an empty bladder as in a full one. This experiment may be easily performed on the dead subject. Indeed, of the two, I prefer the empty or nearly empty bladder to a full one. I do not request the patient to void his urine, but I do not ask him to retain it too long. It is a matter of indifference.

(4) It follows as a corollary, from what has been said, that the circumstance that the bladder cannot retain urine for some hours is not a reason for rejecting lithotritry for lithotomy. It often happens that the subjects of stone cannot retain their urine for more than a few minutes, and some, not for a moment:—

In 1872, Mr. W. S. came to me from Quebec, for the removal of stone. For several years he had been unable to retain his urine. Incontinence was complete. A caoutchouc bag was attached to the penis, and a tube led from it to a larger one which he carried in the leg of his boot. The parts were so excoriated and his sufferings so great that I advised him to submit to the knife. To this he would not consent, and, contrary to my judgment, I was constrained to use the lithotrite. At the first sitting I crushed two large-sized uric-acid calculi, and repeated the operation three days afterwards. After the first operation, and before any of the débris had passed away, the patient could retain his urine two hours; after the second sitting he retained his urine a much longer period; and after the third and last sitting, he was able to retain his urine as long as ever in his life, and, as far as I know, his condition has continued comfortable ever since.

Injectons.—There was, in the early years of lithotritry, remarkable unanimity of opinion in favor of drawing off the urine and injecting into the bladder a certain quantity of warm water, as a preliminary to the use of the lithotrite. There was also remarkable unanimity of opinion as to the quantity—and not less than four ounces, and usually not more than six ounces, was regarded as the cycloid within which it was deemed safe and wise to oscillate. It was also considered necessary to know what quantity of water the bladder would tolerate within it, and, this quantity being a known quantity, the bladder's capacity, ascertained in this way, became its known capacity. It was also imagined and taught that, tepid water being less irritating than urine, the bladder would be tolerant of the presence of a greater amount of the former than of the latter fluid. But urine is proper to the viscus which contains it, and is less irritating to its coats than any foreign fluid, however bland, just as the secretion of the lachrymal gland, more irritating than water, is more grateful to the eye which it bathes; moreover, as Pollock says, "other things being equal, there is no benefit in tepid water over urine as a medium in which to crush a calculus." In later years the orthodox four or six ounces was reduced to two ounces, and still more recently some distinguished operators have discontinued the use of injections altogether. I have never practised filling the bladder with warm water: it seems to me but a mischievous and unnecessary meddling, and the reasons for the use of injections have never appeared to me cogent. On the contrary, I have always observed that when practised by others the procedure is a painful and distressing one, not free from danger, and of a nature to arouse patients from apparently deep sleep. Indeed, I have generally noticed that the injection causes more pain than the sound or lithotrite, and that even when chloroform is used, there is rarely an occasion on which the sleep is so sound as not to be easily disturbed by the injection. Some surgeons, however, run into the extreme of operating only when the bladder is full, and when the patient is experiencing a strong desire to micturate. It is preferable to operate when the

bladder contains some fluid, and a practical method is to suggest to the patient not to make water immediately before submitting to the employment of the lithotrite. Sir Henry Thompson's plan is a good one—to ask the patient “to retain his urine for a little less than his accustomed period before the sitting; that is, if naturally he is able to retain his urine for about an hour, he is requested to pass it forty minutes before the time of the visit.” In this way the inconvenience of an empty bladder, and the still greater inconvenience of a too full bladder, are both avoided.

But even this moderate desire for a small quantity of urine in the bladder cannot always be gratified, as in the case of the gentleman from Quebec to which I have already referred. I reluctantly employed the lithotrite in this case, yet I never had a more favorable recovery. Since then I have never regarded with any apprehension the opening and closing of a lithotrite in a bladder which was intolerant of the presence of even the smallest quantity of urine, nor has it occurred to me to supplement the vesical contents with warm water. Injections have been recommended in the erroneous belief that without them the play of the instrument would be restricted, or that the walls of the bladder would be caught between the blades of the lithotrite and injured. But it should be borne in mind that, as already pointed out, the walls of a healthy bladder are not closed and contracted upon its contents, but that they lie loosely and lightly in contact, receiving within them the water which trickles along the ureters without any *vis a tergo* or pumping power in kidney or ureter. The degree of fullness of the bladder admittedly influences the search for stone. Acting on this assumption, Civiale had constructed a lithoclast—a small, short instrument with a groove along the centre of the male blade—which permitted the urine or the injected fluid to escape slowly; and, while it was escaping, the instrument was turned in every direction to search for the stone.

Size of Lithotrite.—It was formerly the custom, sustained by the approval of the late Sir W. Fergusson, to commence the operation with a large-sized lithotrite; to break the stone into pieces, and then to take a smaller instrument to reduce the fragments to less proportions, so that they might more readily pass through the urethra. But if the lithotrite used in the first instance be not too large, not more than 11 or 12 of the English scale—one not too large to be easily manipulated, yet not so small as to be in danger of being bent or broken—it is better to keep to the same instrument throughout. The length of the instrument must be proportionate to the length of the canal. In children the canal is short, and a short, small-sized instrument suffices; but in cases of enlarged prostate in elderly persons, where the canal, especially at its prostatic end, may be elongated several inches, the necessity for a long lithotrite is obvious. A lithotrite of about twelve inches is sufficient for ordinary purposes; but, in some cases, anything under fourteen and a half inches would be inadequate.

METHOD OF OPERATING.—The patient's body should be so elevated that the surgeon's right arm, while operating, may be nearly horizontal. If the patient is in bed, the surgeon should be seated at his side; if the patient is on the operating table, the surgeon should stand.

The operator being upon the right side of the patient, who lies upon his back, with his head and shoulders elevated and his thighs flexed, the closed lithotrite, well oiled and in the right hand, is slowly introduced within the meatus in the same manner as an ordinary catheter, the penis being supported merely—not seized—by the index and middle fingers of the left hand. It is of small moment on which side the operator chooses to place himself; but it is of importance that, having elected one side, he should keep to it.

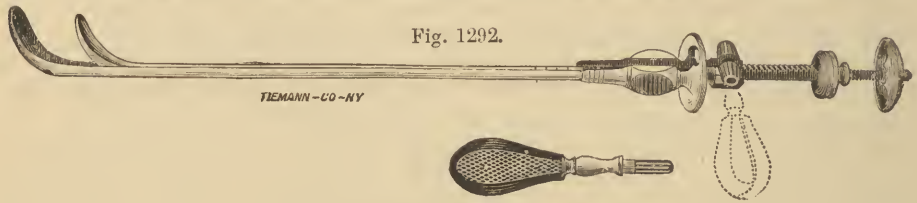
At the beginning of my hospital career the right side of the patient seemed to me preferable, and I adopted it, and now, from habit perhaps, consider it the easier and more natural one. I therefore recommend it. It was the position which I generally saw selected by Civiale and by Sir Philip Crampton. The introduction of the lithotrite is practised by some indifferently, either sitting or standing, and on the right or left side of the patient.

If, with an instrument of such inconsiderable weight as a catheter, it is not allowable to add much additional weight, still less is it allowable with an instrument already many times heavier. The increased weight of the lithotrite is alone more than sufficient, when once it has passed the meatus, to insure its passage along the urethra and into the bladder. The calibre of the canal is nowhere less than at the meatus, and here alone a slight amount of pressure, with a somewhat rotatory movement, may be allowable. The meatus is rarely as wide as the rest of the urethra, even in the healthiest persons and in those who have never had balanitis. My experience in this respect corresponds with that of Mr. Berkeley Hill, who thinks that the meatus is "normally narrower than the rest of the canal, or that its morbid contraction is exceedingly common." The meatus once passed, no difficulty is generally experienced till the instrument is beneath the pubic symphysis, when its handle must be depressed. This carries it beyond the membranous portion, where delay sometimes occurs, and to the prostatic, where difficulty is sometimes experienced, especially in old men, in whom prostatic enlargement is usually accompanied by elongation of the corresponding portion of the urethra, to such a degree as sometimes to lead the inexperienced surgeon to believe that his lithotrite is already in the bladder, when its point may be impinging against the superior wall of the urethral canal. When within the bladder, it is advisable to advance the instrument well along the floor of the organ, to make sure of its being completely within the cavity, before commencing the search for the calculus. Not infrequently the instrument as it advances strikes against the stone. If not, it is to be again slowly withdrawn to just within the neck, when the instrument is made to dip gently from right to left and from left to right of the median line, then from front to back and from back to front. Sometimes the point of the instrument requires to be elevated, sometimes to be dipped backwards, but always with the greatest gentleness; and sometimes, also, the difficulties experienced when searching with the sound are again renewed with the lithotrite, difficulties arising in great measure from concealment of the stone in a saccular depression behind an enlarged prostate, from the floating about of a small calculus in a capacious bladder, or from the diminished space in an irritable one. Sometimes it is considered necessary to turn the patient on either side, and various contrivances have been suggested and used for the purpose, the most complete perhaps being that of Reliquet, which elevates the pelvis at will or turns it in either direction. But without any special apparatus an air pillow will be found convenient. I have never had occasion to turn patients upon the side, and prefer having them always upon the back. One is less apt to forget the relations of the lithotrite to the body when the patient is in that position.

When the calculus is touched with the still closed lithotrite, it is well to determine on which side it lies, so that the instrument, when opened, may the more readily grasp it. But though desirable this is not essential, and the investigation should not be pursued at the expense of any suffering from manipulation that can be avoided. When the stone is again felt, the male blade is gradually withdrawn and again pressed home, while the female blade rests against the back of the bladder, the penis in the mean time being gently held in position. In this way the stone will gener-

ally be at once seized within the blades. If not, the instrument is again and again opened and closed, while gently turning it to the right and left, and backwards and forwards.

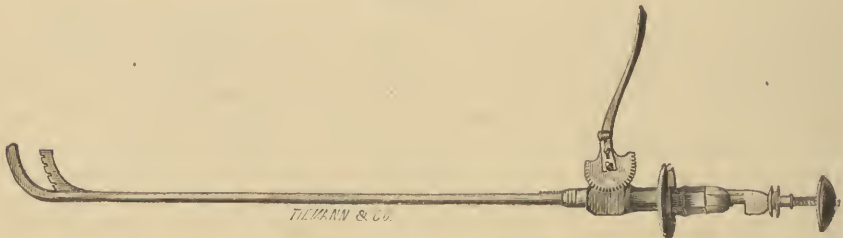
When seized, the stone is to be dealt with according to the particular method which has been decided upon. If it is contained within a litholabe, the stone is broken with blows from a hammer, of sufficient force and quickness to crush it without injuring the instrument.¹ If with the rack and pinion lithotrite, the penis is held in the same manner, and the handle, which is sometimes on the right side, sometimes on the left, is worked by the right or left hand, the penis and contained instrument being held by the other. As the rack-and-pinion instrument cannot be worked without more or less



Rack-and-pinion lithotrite.

movement of its point within the bladder, it is objectionable. The same objection applies with equal force to the lever instrument (Fig. 1293), which requires too much movement of the right hand. I have discarded both for

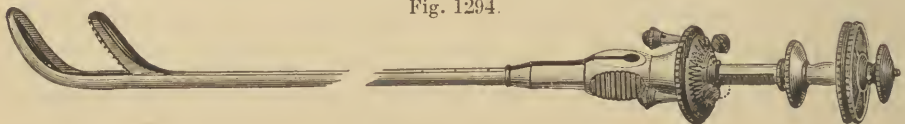
Fig. 1293.



Lever-lithotrite.

the, to my mind, more satisfactory lithotrite of Civiale, which may be easily worked, with or without the screw, this being released or attached by turn-

Fig. 1294.



Civiale's lithotrite.

ing what instrument-makers call the revolving cap. Weiss's lithotrite has all the advantages of Civiale's, and also an additional merit. The screw power is in connection with the male blade, and is more readily released, this being accomplished by placing the thumb of either hand upon a button on the handle, the movement being effected in a line with the shaft of the instrument. But the cylindrical form of the handle, added by Thompson, though admitting of greater force in the hands of the operator, does not permit the same delicacy in manipulation as does Civiale's round-headed instru-

¹ I mention this method, though now obsolete.

ment. That instrument is, however, the better to which the operator is the more accustomed.

Sir Henry Thompson's lithotrite¹ has considerable advantages for stones that are neither too large nor too hard. The instruments hitherto described are fenestrated. Thompson's has a small opening, yet for all practical purposes is closed, and the depression in the female blade permits it to receive and retain a considerable quantity of the fragments, which may generally be removed without injury to the canal. The means of releasing and of attaching the screw are placed on the handle of the female portion of the instrument. But to Thompson's, as to all flat lithotrites insufficiently fenestrated, there are these objections: they become quickly filled with fragments, large and small, and the female blade, no matter how full, still permits additional matter to be pressed into it by the male blade, when perhaps the blades, separated by calculous matter, cannot be accurately closed, and have to be withdrawn in this way through the urethra. I have more than once seen difficulty in removing this instrument, and especially through the narrower portions of the urethra, where lacerations have apparently taken place. It is not always easy to prevent the overloading of the female blade, for the first turn of the screw or the first pressure of the unaided wrist may impact it with more than it can contain. The most dexterous must be prepared for this occurrence. Before the time of rapid lithotripsy, before the time of washing out the bladder after the operation for crushing, Sir Henry Thompson's instrument was deservedly a favorite one. It enabled the operator, with a fair-sized urethra, and one tolerant of manipulation and of the presence of instruments, to introduce any number of times an empty lithotrite, and remove a full one. And many times have I completed the operation of lithotripsy in this way in two or three sittings. But, as already stated, repeated introductions and withdrawals are not advisable, however carefully performed, and a prolonged sitting means correspondingly numerous passages of the instrument through a sensitive canal. There are many cases, however, in which Thompson's lithotrite is still the best—cases in which friable and moderate-sized calculi are met with, and in which the urethra is capacious and possessed of a minimum degree of sensibility.

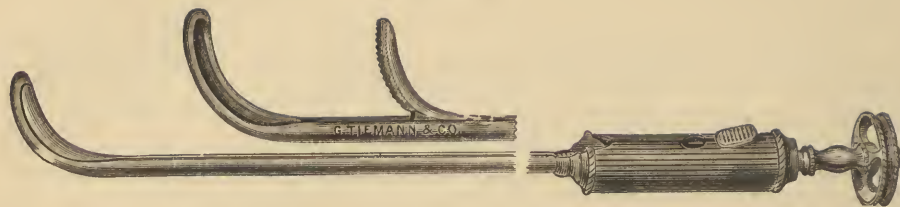
Bigelow's lithotrite² has few advantages over Sir H. Thompson's and Civiale's flat instruments, save that it has a longer and larger female blade, turned down at the end to facilitate its introduction, and fenestrated at the heel for the reception of a projecting shoulder on the male blade. It is a flat instrument, and may be choked in the same way as Thompson's or Civiale's. When closed, the male is completely hidden within the female blade. The instrument breaks the stone effectually, but does not reduce it to fragments. To do this the broken pieces must be seized again and again. Its crushing power is not by any means equal to that of the open, fenestrated instrument; and it works by continuous pressure rather than by sharp, distinct, and interrupted crushings. The absence of lateral guides on the handle, to tell when the screw is on or off, is confusing; but the instrument-maker can easily remedy this defect.

Dr. Gouley's lithotrite (Fig. 1295) has some advantages not possessed by other instruments, but has disadvantages also. The edges are sharply cutting, but the bulk of the stone must be reduced by pressure, and pressure of a continuous kind. The dread of cutting the walls of the bladder by an instrument apparently equal to that work, is ill-founded. In this respect its construction offers nothing more hazardous than that of the instruments longer in use.

¹ See Figs. 1220-1226, pages 789, 790, *supra*.

² See Figs. 1227-1229 page 791, *supra*.

Fig. 1295.



Gouley's lithotrite.

France, unwilling that other countries should outstrip her in the perfection of instruments for crushing stone, in which, for so many years she excelled, has not been idle. Civiale's, Heurteloup's, and Leroy d'Étiolles's instruments have been variously modified in handle, shaft, and blade. But more recently Reliquet has furnished a lithotrite which has certain advantages over other instruments, especially in reducing calculi to fragments sufficiently small to enable them to pass through the evacuating canula.

The advantages of Reliquet's instrument are chiefly these: (1) the oblique disposition of the teeth on the margin of the female blade prevents the calculus from slipping towards the point when the teeth of the male blade cut and crush it. (2) The teeth of the male blade act singly upon the imprisoned calculus, and drive it against the transverse teeth in the female blade, between which it is reduced to the desired size, the fragments falling behind and out of the way of the male blade. Hence (3) the disadvantages of over-filling the female blade, and of necessitating the frequent withdrawal of the lithotrite to clean it, as in flat instruments, are avoided. But there is also a drawback to the general use of the instrument. When it is closed, the teeth of the male blade project beyond the female, below, and the serrated margins of the female blade, above, are free. In its closed condition the instrument can neither be introduced nor withdrawn; the blades must be partially open, and by a piece of mechanism this action is limited. Operators familiar with other lithotrites, which are always firmly closed prior to introduction or withdrawal, are apt to be unprepared for this novelty. A small blade, less deep, and one which would occupy less space when closed, would answer every purpose. In spite of this defect, however, much of what its enthusiastic inventor claims for it must be admitted, and especially the advantages of a flat instrument without the inconveniences of clogging, enabling the lithotrite to be manipulated for any length of time within the bladder without the risk of difficulty in its removal. It can be used with the pressure of the palm of the hand, or with the screw as in ordinary instruments, or, in cases of hard stones, with percussion by a hammer.

Duration of Operation.—This also has been greatly modified. French surgeons place the utmost limit of duration, beyond which it is imprudent to go, at twelve minutes. “Après cinq, huit, dix, ou tout au plus douze minutes, il convient de terminer la séance,” says Velpeau. Other operators since then have greatly increased the duration of the operation. I have many times manipulated the lithotrite for an hour, and Bigelow in this country, and many operators in Europe, have advocated much more prolonged sittings, but, as I shall have occasion to point out, the risk to the patient is not diminished thereby.

RAPID LITHOTRITY.—It was, as it were, but a swing of the pendulum between permitting, in all cases, the fragments of a calculus to find their way

out of the bladder, without injection and without aspiration, and allowing no portion of a calculus to remain after fragmentation without being washed out through the urethra, or drawn out through a canula.

If error there were in the former practice, the error was in its universal adoption. And the error into which many have recently fallen, of washing away the fragments in every instance, is an error fraught with no less mischief. It is but a few years since the greatest surgeons were content with "crushing the stone, and waiting for the gradual and spontaneous egress of the fragments." Some, like Fergusson, had tried single and double injections and currents of water, but with so little satisfaction that "forcible disintegration and chance were finally trusted to," chance generally bringing away in due season the fragments which had been broken off, after they had lodged perhaps for a time in the prostatic or membranous portion of the urethra, or at the meatus. It is less than twenty-five years since it was generally considered unwise to touch fragments of stone in the bladder, or to attempt to bring them away.

In speaking of injection as a preliminary to crushing, I gave among the reasons for its non-employment, the irritation set up in the bladder which it was not in the power of an anæsthetic completely to mask; the same objection would obtain, in a considerable proportion of cases, to the use of injection as a sequel to crushing. Professor Andrews uses "warm carbolized water during the whole operation of litholapaxy, both to distend the bladder during the crushing, and to wash out the fragments afterwards;" but, granting that "carbolized water acts as a decided local anæsthetic, benumbing the nervous activity of the bladder and lessening the shock of prolonged operations;" granting that "it checks bleeding, and leaves the viscus in a thoroughly antiseptic condition, preventing the formation and putrefaction of pus, and acting as a very powerful local antiphlogistic"—granting all this, and it is granting much—the wisdom of its use in mechanically distending the bladder as a preliminary to, or during the operation of, crushing, may fairly be doubted. The addition of carbolic acid to water cannot diminish—and it is not pretended that it increases—the undesirable *mechanical* action of warm water forced into the bladder through the urethra, though in the cystitis which accompanies the presence of stone, and which may continue after its withdrawal, the injection of a warm one-per-cent. solution of carbolic acid may be, as Mr. Batterham says, "most efficacious in allaying pain."

The aim of every operator, from the time of Civiale to the present has been, however, to diminish the inconveniences arising from the passage of these fragments. The fragments produced by the earlier instruments were not as large, indeed, nor as angular, as those produced by later instruments. The earlier lithotrites did not break the stone into pieces, but scraped its surfaces and gradually reduced it to powder or to small gravel, and the quantity broken down at each sitting was not as large as that obtained now. Yet fragments of considerable size could sometimes be detached. Accidents which occurred from time to time from their being lodged in some part of the urethral canal, led Leroy d'Étiolles to recommend an evacuating canula, and Heurteloup to introduce an instrument which has since, in the modification of Sir Henry Thompson, nearly reached perfection as a means of retaining the fragments within the female blade and permitting their extraction in this way. But this latter instrument is used on the assumption that the urethra is less susceptible of mischief from the introduction and withdrawal of a metallic instrument, than is the bladder from the presence of fragments. Civiale desired the detention of the latter within the bladder till their angles were rounded off, and Heurteloup advised the maintenance of

the recumbent posture to retard their departure. This practice has since, till comparatively recently, been very generally observed.

For washing out the bladder, it is necessary that tepid water should reach the organ in sufficient volume to bring back with it in its reflux the débris of the calculus. It is necessary, therefore, that it should reach the bladder with a certain degree of rapidity, and with a certain amount of force. And here precisely is where the difficulty appears to occur: an elastic bag in the grasp of an assistant's hand at one end of an unyielding tube; and a bladder more or less diseased—with ureters perhaps unhealthy, and kidneys more or less changed in structure—at the other. Every pressure of the hand on the rubber bag is felt at every portion of the bladder, and through the constricted orifices of the ureter, the pelvis of the kidney, and even through its tubuli uriniferi at the cortical walls. I confess that in the performance of rapid lithotrity, my chief anxiety formerly began with the injections; not that the integrity of the passive, good-natured bladder was to be feared, but rather that of the delicate structures beyond, whose office it was to separate from the circulating fluid the peccant urea which it contained. For, however correctly we may estimate the propelling force at one end, we cannot so easily estimate the resisting power at the other. Sometimes the bladder commences its expulsive efforts at the first entrance of the fluid, and it is not easy to distinguish between the normal resistance offered by a healthy bladder when full, and the spasmodic efforts of an irritable one to prevent its becoming full.

The bladder may, without much disturbance of its functions, suffer a certain degree of gradual distention from within; but distention from without by a fluid which, however bland, is foreign to it, is not equally free from mischief. I have always observed, when patients have been under the influence of chloroform, and have generally been assured by those who were not under the influence of an anæsthetic, that their sufferings began with the injection of water, and not when the lithotrite was doing its work of disintegration and before any effort was made to urinate. Still, as the advantages of getting rid of a calculus are so great, and as there are but two methods of effecting this rapid delivery, that by washing out the bladder will continue to be the favorite in the greater number of cases. But great gentleness in manipulation and lightness in pressure, with due recognition of the resistance which the bladder offers to the distending liquid, must be cultivated. As the accoucheur can perceive uterine contractions before the patient herself, so likewise can the surgeon recognize the efforts of the bladder to expel its contents before the patient is aware of them.

But rapid lithotrity, in the days when it was first recommended, was not what is meant by that term to-day. Rapid lithotrity meant operating as long and as often as it was believed that the bladder would tolerate the presence of a solid instrument within it, without in any manner jeopardizing its integrity. Rapid lithotrity meant crushing a stone, waiting for the bladder to recover itself (a period usually thought to be not less than three or four days), and then searching for the fragments and dealing with them as in the first instance; and that lithotrity was most rapid in which the shortest interval existed between the sittings. Cautious men allowed intervals of ten or fifteen days, and limited each sitting to four or five minutes. Rapid lithotrity to-day, however, means something far more rapid and far-reaching in its operation, and far more satisfactory in its results. Rapid lithotrity often means the removal of a calculus at a single sitting; a most desirable result, certainly, but one which must sometimes be purchased at the expense of much unnecessary inconvenience and suffering. Rapid lithotrity, conducted with care and prudence, and with due regard to the patient's general and local condition, is a most satisfactory procedure; but rapid litho-

trity, when it means the invariable completion of the operation at a single sitting, may mean suffering, disaster, and death. Long sittings are not invariably well borne, and are, therefore, not invariably wise. It must not be imagined that, because the patient is anæsthetized, no inconvenience will result from prolonged manipulation. The same intolerance of instruments may exist when the patient is asleep as when he is awake, though he may be unable to give any outward manifestation of that intolerance. To generalize the application of long sittings, therefore, is a grave error, and success is more likely to attend the practice of those who correctly appreciate the degree of irritability proper to the individual bladder, and proportion the length and duration, and the force, of their manipulations, with due regard to the balance of all the parts entering into the formation of the urinary apparatus, than of those who regard only the size and hardness of a calculus, and the cubic capacity of the viscus which contains it. Not alone has the bladder to be considered: to my mind the condition of the urethra is of still greater moment; not alone its calibre, but its individuality, so to speak; and more than these, the kidneys—those organs which are so often at fault in calculous subjects, and which, unluckily for the operator and for the patient also, may be diseased without giving rise to any appreciable abnormal condition of the urine. The first break in my last series of thirty-five successful cases of lithotritry occurred in this way.

One of the most marked modifications of this operation, which more than any other, perhaps, has undergone important changes since the days of Civiale, who, less than sixty years ago, first introduced it to notice, is the getting rid, without cutting, of a stone even of considerable size at a single sitting. This important modification is due in principal measure to Dr. Bigelow, of Boston, who advocates crushing the stone, and washing out all the débris, at a single sitting. It will not take from the great credit due to Professor Bigelow, for it to be said that the recommendation to wash out the bladder did not originate with him. More than twelve years ago, Dr. L. Aug. Mercier, in a little book entitled "*Traitement préservatif et curatif des sédiments, de la gravelle, de la pierre urinaire, et de diverses maladies dépendant de la diathèse urique*," recommended washing out the bladder, and gave a cut of an instrument made for him for the purpose some years before by Charrière, of Paris, and which was not unlike the first India-rubber bag employed in this country. Mercier's method was not generally adopted, however, and it was usual till quite recently to trust to chance for the passage of the fragments. It was only when chance did not suffice¹ that return was again had to the lithotrite, and to large-sized, large-eyed catheters, or to the use of a small scoop.

But the instrument now used by Bigelow so far surpasses Mercier's, that it may be said to be a new one; and the knowledge acquired, chiefly through the observations of American surgeons, of the greater calibre of the male urethra and of its greater tolerance of large-sized metallic instruments than was formally believed, has changed the views of lithotritists as to the best means of dealing with the fragments of a calculus. Judging from the improvements which are constantly being made in it, Bigelow's instrument may not yet have reached its highest point of perfection; but in its latest form¹ it closely approaches it.

There remain to be said a few words on the method of using it; the work of crushing being ended, a canula of the full size of the urethra is introduced, when, warm water being in readiness and the canula being attached to the pumping apparatus, the slightest pressure of the fingers and thumb on the rubber ball—a force not more than sufficient to dimple its walls—suffices to

¹ See Fig. 1248, page 806, *supra*.

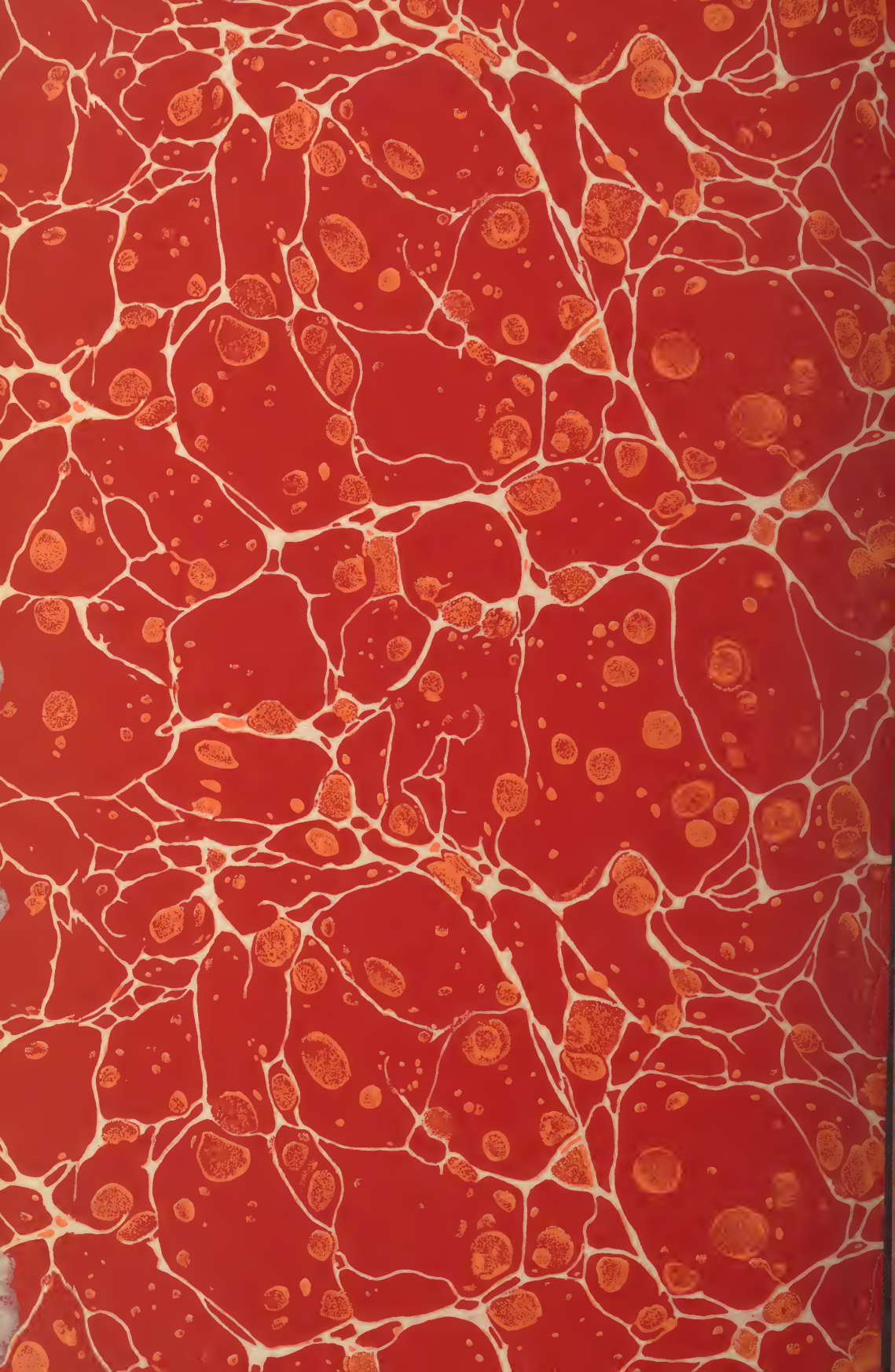
agitate the fragments of the calculus and bring them within the large eye of the tube. The appreciation by Dr. Bigelow of the very gentle pressure which suffices to put in motion fragments differing but little in specific gravity from the fluid in which they were originally formed, entitles him to the gratitude of every sufferer from vesical calculus who desires to be rid of it with the least possible delay, and with the least possible pain.

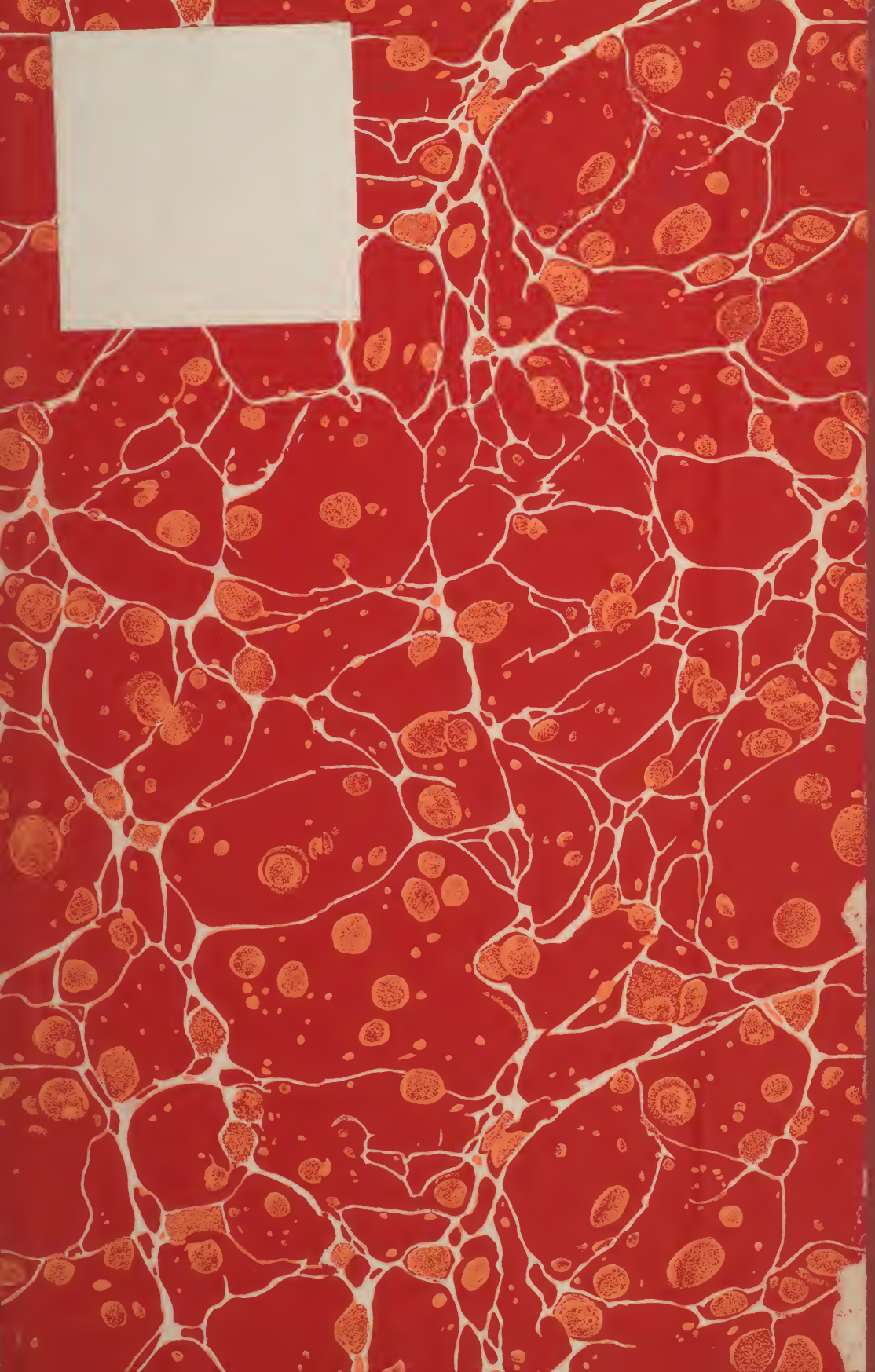
LITHOTRITY IN THE FEMALE.—We are not often called upon to operate for stone in the bladder in the female. The anatomy of the female urinary apparatus favors the early escape of calculi through the urethra, and before they have attained a size to require the surgeon's assistance. But in those exceptional cases in which the calculus remains within the bladder, it must be extremely rare for any other operation than crushing to be called for. If neither stricture nor enlarged prostate is an insuperable obstacle to crushing in the male, how much more favorable is the female urethra for the manipulation of crushing instruments? Its shortness and its large normal calibre, susceptible of considerable increase by the use of the lithotrite, render extraction of stone by incision into the bladder, either through its neck or through the vesico-vaginal septum, rarely necessary; and still more rarely is the more formidable supra-pubic operation called for, except in cases of immensely large and hard calculi.

LITHOTRITY IN CHILDREN.—For a long time it was felt that in children, at least, lithotomy would continue to hold its place, the operation on them being usually considered an easy and a safe one. But, however safe the operation may usually be considered, and however easy of performance, we sometimes meet with unexpected difficulty and delay in its performance, and with disappointment in its results. The most accomplished surgeons have failed to reach the bladder, the left index finger going deeply into the perineum and pushing the prostate and neck of the bladder before it, and have well nigh abandoned the operation under the impression there was no stone, when in reality the bladder had not been opened. Two cases of this kind have come under my notice: in both long gropings occurred, and in one the prostate and neck of the bladder were pushed before the finger, leading to a suspicion of faulty diagnosis. Fortunately the operators did not trust too implicitly to the finger. This risk is mentioned merely incidentally, to show that lithotomy in children is not always completely free from difficulty. In the mean time the sphere of lithotritry has within the past few years been greatly extended, and it is possible that hereafter it may be found preferable in selected cases even in children.

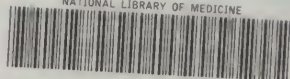








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